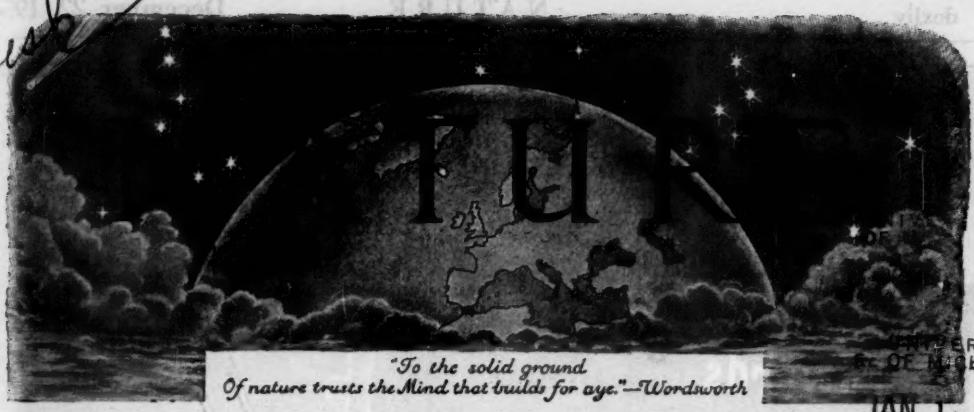

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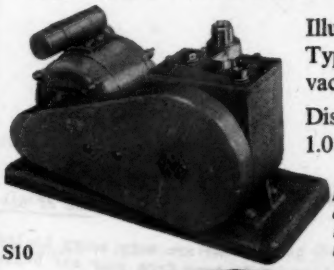

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NATURE

No. 4547 SATURDAY, DECEMBER 22, 1956 Vol. 178

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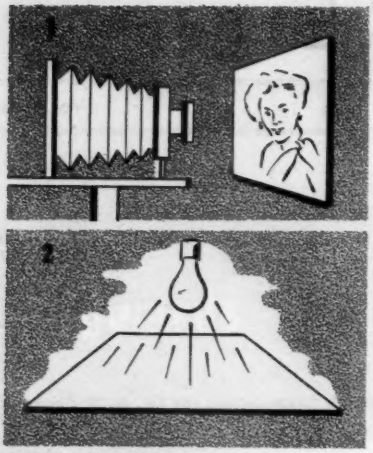

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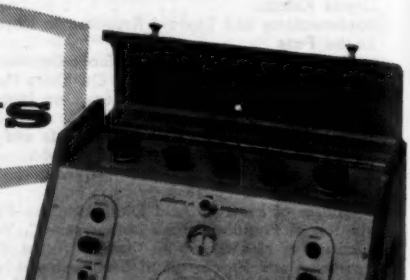

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MAN-POWER PROBLEMS IN THE FACTORY INSPECTORATE OF BRITAIN

IN a statement in the House of Commons on May 18, Mr. Robert Carr, the Parliamentary Secretary to the Ministry of Labour and National Service, said that the Minister had just received the report of an inquiry by three senior officers into the staffing and organization of the factory inspectorate, and that it was proposed to increase the strength of the engineering and chemical branch of the inspectorate from eighteen to forty-four, thus permitting one engineering inspector and one chemical inspector to be stationed in each division; further, the strength of the general inspectorate was also to be increased so as to enable inspectors to pay more attention to building operations and engineering constructional work. The report, which was prepared by the Under-Secretary in charge of the Safety, Health and Welfare Department of the Ministry, the Director of Organizations and Establishments and the Chief Inspector of Factories, gave a factual survey of the work and staffing organization of the factory inspectorate and made certain recommendations on some problems likely to arise in the light of future developments. Although the full report has not been published, a White Paper which was issued in October* gives a sufficiently full summary of the results of the survey for a reasonably informed judgment as to the adequacy of its recommendations, some of which, as Mr. Carr announced in May, were immediately accepted by the Minister.

The White Paper is in fact of scientific interest for several reasons. It gives, in the first place, a concise but clear summary of the functions and work of the inspectorate, which enables an independent judgment to be formed as to the importance of technical and scientific knowledge on the part of the inspectors. This chapter also includes a comparison of the work before the War and that to-day, and discusses the factors that have changed or increased its work, and future changes that are likely to affect the work of the inspectorate. It would be difficult to improve on this admirable description of the work of the inspectorate; and since it indicates the place of the inspectorate in the industrial life of Britain and its contribution to industrial efficiency as well as to welfare and safety, it deserves to be read by every scientist engaged in industry. Little imagination on the part of the reader is required to appreciate how much depends on the co-operation of the scientist and technologist if the work of even the strongest and most efficient inspectorate is to have full effect.

The primary duty of the factory inspectorate is to promote and enforce the uniform observance of the provisions of the Factories Acts, and regulations made under the Acts, though inspectors have also duties under the Truck and other Acts in relation to factories. Inspection may take the form of special visits to inquire into particular problems, or may be substantial inspections of a routine character to ensure that there is general compliance with the Acts; and it will be recalled that it was the revelation of a widespread failure to comply with the regulations in regard to precautions against fire that shocked Parliament when Mr. Carr made his statement in May. In these routine visits, attention must be paid not merely to general precautions against fire but also to particular safety problems such as the guarding of machines, the proper maintenance of lifting tackle, boilers, air receivers, etc., and the committee of inquiry considered that thoroughness of inspection was far more important than frequency of visits.

Until December 31, 1954, the inspectorate endeavoured to comply with the general standards of inspection recommended by the departmental committee of 1928 and to visit the more important factories and workshops at least once a year and the less important works at least once in every two years, and to give every works in Britain a thorough inspection within an average period of four years. The standard of an annual visit has never been, and is unlikely to be, achieved, and the revised scheme introduced on an experimental basis on January 1, 1955, appears to receive the unreserved support of the committee of inquiry. Under this scheme the general principle of inspection once in every four years is maintained; but the district inspector, under the direction of the superintending inspector, decides which factories shall be accorded priority for a thorough inspection during the year, having regard to such factors as the nature of the processes, the standard of compliance with statutory requirements, the period since the last thorough inspection, the numbers employed, etc. A small factory with serious risks may have higher priority than a much larger factory where conditions are good, and a factory accorded priority one year may or may not receive priority in the next year.

In view of the subsequent discussion of the work of the inspectorate and its possible reorganization, the figures quoted in the report regarding visits from 1928 to 1955 should be noted. Between 1928 and 1933 there was a comparatively large increase in visits to factories with power, following the increase in staff recommended by the departmental committee. Since then, the number of visits has fallen by 7 per cent, while the number of factories has increased by more than 33 per cent; but taking all factories together, between 1928 and 1955 the number of factories has decreased by 11 per cent, while visits have declined by nearly 22 per cent.

Besides this routine inspection, however, inspectors are instructed to investigate serious accidents, or accidents and cases of disease where there is reason to suspect a breach of the law or some unusual circumstance calling for investigation, and here their

* Staffing and Organisation of the Factory Inspectorate. Pp. 48. (Cmd. 9879.) (London: H.M. Stationery Office, 1956.) 2s. net.

function is primarily to ascertain the cause of an accident. This involves visiting the site of the accident and examining any plant or machinery involved as well as questioning witnesses and any informed person, and interviewing the occupier of the factory and other persons in authority. Here clearly technical knowledge can again be of decisive importance; but there is no clear distinction between the inspectorial and the advisory functions of the inspectorate, and such advisory work can lead to much saving of time in the long run, for example, if the advice of the inspectorate is sought when new factories or extensions to existing factories are planned.

Although the total number of factories has declined from some 260,000 in 1928 to 230,000 in 1955, the number of power factories has increased by some 64,000, and these factories involve substantially more work in inspection; and the more extensive safety requirements of the 1937 Act have added considerably to the work of inspection. Moreover, to play their part in securing improved conditions, inspectors must keep abreast both of advances in knowledge of the effects of certain dust and fumes on the health of those working in their presence and of the efficacy of precautionary measures. The 1948 Act has also added to the work of inspection, and there have been other developments affecting the work of the inspectorate.

On balance, the increase in the number of works doctors increases the work of the medical inspectors, and a principal reason for seeking to increase medical supervision is to encourage an informed and co-operative approach to problems of industrial health. Industries which present special health hazards are being encouraged to extend their medical services, and to press on with investigations into the reduction of the hazards, either by preventive measures or, where possible, the substitution of less dangerous substances. As a result, inspectors on their visits to factories are required to pay increasing attention to ensuring that the health of the workers is adequately protected, and increasing attention to medical supervision may be necessary in the future.

Some developments in industrial processes have increased, and some have reduced, the work of the inspectorate; but there seems to be little doubt that, on the whole, since 1928 industrial developments have increased the volume and complexity of the work of the inspectors. The report notes the growth of consultation with industry and the work in which such consultation has led to a pooling of technical experience and the improvement of conditions on a practical and scientific basis. Most of this work has fallen on the headquarters staff, and particularly on members of the technical branches, who not only serve on the various committees but also carry out the secretarial work. Furthermore, the report refers to some future developments, such as the Ionizing Radiation Regulations at present under consideration and those relating to the use of inflammable substances, which are likely to add to the volume of the work and to its complexity, if not also to the technical knowledge required of the inspectorate. Mr. Carr said in the House of Commons on October 30, for example, that there is at headquarters a physicist engaged full-time on advising the inspectorate and industry on precautions to be taken in regard to radiation hazards, and that fifteen inspectors have already been to courses on radiological protection at Harwell and an engineering inspector was attending a course on the design of nuclear reactors. Inspectors make special visits to factories where there are known to be radiation hazards, and the Atomic Energy Authority informs the inspectorate of all firms to which isotopes are delivered.

To deal with these changes, the inspectorate has increased from a total of 200 in 1928, which included 5 in the medical, 5 in the electrical and 6 in the engineering and chemical branches, to 378 in 1956, of which 18 were in the medical, 14 in the electrical and 18 in the engineering and chemical branches. Moreover, while about 61 per cent of those entering the inspectorate before the War had technical degrees and 68·8 per cent previous industrial experience, only 13·8 per cent of those entering since the War had technical degrees and 48·8 per cent technical experience. As a result, the proportion of technically qualified persons is much higher in the senior grades of the inspectorate than in the junior.

The problems of the Medical Branch are not considered in any detail in the White Paper, and no recommendations are made regarding the organization and size of the medical inspectorate. This is considered as, for practical purposes, a distinct problem; and while much thought is being given to the best way of developing industrial health services, it would be inopportune to make fundamental changes in the organization of the medical inspectorate in advance of decisions on these questions of policy. None the less, the analysis of the problems and conclusions which constitute Part 2 of the White Paper is of general scientific interest, particularly in view of the fundamental approach to the problems which characterizes its analysis and recommendations. It is not disputed that the inspectorate is too small; but it is emphasized that the decision as to the size of the inspectorate must be realistic and determined in relation to the national shortage of scientists and engineers. No government department should compete for such persons beyond the extent that this can be shown to be essential for the prosecution of its work.

It is refreshing to find such emphasis placed on the decisive importance of making proper and economical use of man-power resources in a context in which the impossibility of conceiving a limit beyond which recruitment of an extra inspector could contribute nothing to improve the safety, health and welfare of factory workers; for it can easily lead, as in the debate last May, to proposals which disregard the consequences of failure to use wisely and fully the special skills of scientists and technologists. Moreover, the White Paper keeps constantly in mind that factory inspection is only a means and not an end, though admittedly a most important means, of achieving the objectives of national expenditure in this field—the promotion of health, safety and welfare in factories. Its recommendations come with

greater force in that it envisages the possibility that new developments in industrial processes, an increasing proportion of modern well-built factories, the continuing development of the co-operative spirit in industry and the cumulative effect of the work of the inspectorate over many decades may permit a substantial reduction in the resources of man-power and money devoted to factory inspection.

That time has not yet come; but while the White Paper admits the necessity for some small overall increase in the size of the general inspectorate, it does not suggest that exceptional efforts need be made to increase the recruitment of technically qualified persons. Persons with and without technical qualifications are both required in the general inspectorate, and there is no objective answer to the question in what proportions the two elements should figure. The work of the general inspectors is one and indivisible, and although the range of technical problems is wide, not all the work is technical, and the non-technical officers have the assistance of colleagues, and particularly of senior colleagues, who have technical qualifications. Even the technical officers have often to deal with many matters outside their particular specialities.

While it may well be that a general scientific background and attitude of mind will enable an inspector to deal better with technical questions, whether or not they fall within his special subject, and while it may also be true that failure to recruit a reasonable proportion of technically qualified inspectors may lead to a serious drop in the quality of the inspectorate as a whole, the committee does not think that the point has been reached which would justify special efforts to increase such recruitment. Every effort should be made to increase interest among technically qualified persons at the universities and elsewhere, but the main effort should be to relieve the inspectors of routine or other work which can be handled elsewhere and to provide them with more efficient services. Greater advantage should be taken of the opportunities to streamline administration resulting from the fact that the inspectorate is now part of a Ministry, with a nation-wide organization of regional and local officers, and the inspectorate's boundaries should be re-aligned to run with those of the Ministry's regions, subject to exceptions where necessary.

The detailed work required to give effect to these recommendations has already been initiated, and a detailed study is also being made of the possibility of relieving inspectors of the non-technical work of enforcing the provisions regarding hours of work. These are sensible proposals which should reduce the risk of wasting the special knowledge or experience of the inspectorate; and the increase in the Engineering and Chemical Branch already announced should also help. The posting of a specialist engineer and a specialist chemist in each division is suggested primarily to reduce delays and relieve the burden on the specialist inspectors at the central office; but it is probable that some saving of the time of general inspectors should also result. More particularly, however, it should maintain and develop the technical resources of the inspectorate in the way that makes the most economical demand for the services of professionally qualified scientists and engineers. Lastly, a full-scale review of staff training is now in hand with the object of formulating a policy which takes full account of post-war problems.

The immediate reason for undertaking this survey was the difficulty experienced in recruiting to the factory inspectorate as many men and women with technical qualifications as had been customary in the past. The White Paper does not differentiate between men and women, nor examine the question whether in the present situation increased use might be made of women, particularly of those with technical qualifications. Nevertheless, as a survey of the staffing and organization of the inspectorate it is excellent; its analysis is clear and concise, and its recommendations are sound and practicable. But it is as an appendix to the recent report on Scientific and Engineering Man-power in Great Britain that it is of even greater importance and significance, for it demonstrates the approach to the use of such man-power that is imperative in industry and elsewhere as well as in government departments, if Great Britain is to achieve any solution of its man-power problems.

THE CHANGING FACE OF ORGANIC CHEMISTRY

Perspectives in Organic Chemistry
Edited by Sir Alexander Todd. Pp. x+527. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1956.) 7.50 dollars. 55*s*.

THIS year chemists have celebrated the centenary of Sir William Perkin's discovery and the manufacture of the first synthetic dyestuff, mauveine. They were celebrating also the real birth of organic chemistry, since it was the manufacture of this and of other dyestuffs which provided the real stimulus to investigations into the detailed structure and reactions of organic compounds. A perusal of Perkin's original memoirs and other publications of this period shows that in 1856 chemists had no knowledge of the structure of organic compounds and it was not until nine years later, in 1865, following Kekulé's classical paper on benzene, that any real progress was possible.

During the past fifty years it is doubtful if any individual chemist has made a greater contribution to our knowledge of organic chemistry than Sir Robert Robinson. His early interests lay in the determination of the structure and the synthesis of natural products. This followed from his association with his teacher, Prof. W. H. Perkin, a master of experimental method. Robinson's classical paper on the biosynthesis of alkaloids, published in 1917, provided the guide to much of his future work, culminating in his determination of the structure of strychnine and his synthesis of the sterols. This work alone would place him in the first rank of organic chemists; but he is unique in that he, unlike his teacher, was greatly interested in organic chemical theory. During the years 1920–26 he laid the foundations of the modern theories of organic chemistry and of the

mechanisms of organic reactions. The younger school of organic chemists fails at times to recognize this major contribution to their science.

On September 13 Robinson attained the age of seventy, and as tribute to his friend and former teacher Sir Alexander Todd has edited a series of essays entitled "Perspectives in Organic Chemistry". The contributors include not only his former students and collaborators, Sir Alexander Todd, Profs. Wilson Baker, E. L. Hirst, H. Erdtman, E. Schittler, Dr. J. W. Cornforth, but also many foreign friends, L. Pauling, K. Folkers, A. Butenandt, L. Ruzicka, K. Ziegler and R. B. Woodward. It would be impossible in any short review to do justice to this remarkable series of essays; each of them is in its own way masterly, and they should be read and re-read by all organic chemists. They suggest that organic chemistry is at the cross-roads. In the past two decades the techniques available to the organic chemist have been greatly refined. New methods of purification, such as paper chromatography, vapour-phase chromatography and counter-current distribution, have been developed, while increased assistance can also be obtained from infra-red and ultra-violet absorption spectra. Yet the recent reliance on R_F values and of infra-red spectra alone as a proof of identity, in the absence of direct chemical evidence, must be deplored. As Prof. Woodward points out in his brilliant essay "Synthesis", this branch of our science, apart from its intellectual attraction, has still a major function to perform. Will not these new techniques enable the organic chemist to attack more successfully the chemistry of life? Dr. Cornforth, in concluding his essay on "Isotopes in Organic Chemistry", rightly suggests that organic chemistry and biochemistry can no longer be regarded as distinct disciplines. This is well illustrated by the contributions of Dr. Folkers' "Micro-organisms in Organic Chemistry", Sir Alexander Todd's "Nucleic Acids" and Prof. Erdtman's "Organic Chemistry and Conifer Taxonomy".

We feel that all chemists will be grateful to Sir Alexander Todd for having edited this remarkable tribute to a great chemist. It is beautifully produced, and an excellent coloured photograph of Sir Robert Robinson forms a frontispiece. It is unfortunate that its somewhat high price may limit its circulation.

J. L. Simonsen

ZOOLOGY OF ICELAND

Zoology of Iceland

Four volumes (65 parts). (Copenhagen: Ejnar Munksgaard, 1937–1955.)

THE publication of this ambitious work started in 1937, and by July 1956 sixty-five parts, divided into four volumes, had appeared, and the preparation of six more was announced. It will doubtless be several years yet before the end is in sight. The "Zoology of Iceland" is already of great value to zoologists working in many fields of their subject, and when complete it will be the standard work for a century or more. Its scope is wider than usual with similar faunistic surveys, for it aims at a complete description of the occurrence, range, and biology, so far as they are known, of every species of animal—terrestrial, freshwater and marine—that has been found in Iceland and the surrounding seas: a truly colossal task.

All the parts are written by authorities in their respective fields; most of the writers are Danish or Icelandic, but the editors have enlisted the help of those of other nationalities wherever desirable. The editors have also wisely ensured the widest availability of the work to zoologists by publishing it entirely in the English language.

Each part of volumes 2, 3 and 4 deals with a separate group of animals, generally an order, though in some the group is larger and in others smaller. The general plan is to start with a short historical introduction and then to provide a full synopsis of the species, giving status, records of occurrences, distribution outside Iceland, and short notes on biology. This is followed by a section of general remarks and discussion on the biology of the forms concerned and their zoogeography, and by synoptic tables. Each part concludes with a full list of references.

Volume 1, however, contains the papers of widest interest: Part 4, "The Hydrography of Icelandic Waters", by Helge Thomsen, Part 6, "The Benthonic Animal Communities of the Coastal Waters", by R. Spärk, and Part 11, "The Hot Springs, their Animal Communities and their Zoogeographical Significance", by S. L. Tuxen. The last is a very thorough account of the subject, and the author concludes that some of the members of the hot-spring fauna have probably been present for some 100,000 years because their warm environment enabled them to survive the last ice age. Indeed, he goes further and suggests that they may have survived the earlier ice ages too, and thus have perhaps been present throughout the whole of the Pleistocene period. This paper is illustrated with a number of interesting photographic plates.

When this great work is complete, no similar region of the globe will have such a comprehensive written history of its fauna. It will be an example and an inspiration to zoologists all over the world to work towards producing like surveys of the regions with which they are familiar.

L. Harrison Matthews

PHYSIOLOGY OF REPRODUCTION

Marshall's Physiology of Reproduction

Edited by Dr. A. S. Parkes. Vol. 1: Part 1. Third edition. Pp. xix+688. (London and New York: Longmans, Green and Co., Ltd., 1956.) 150*s*. net.

THE first edition of the late Dr. F. H. A. Marshall's "Physiology of Reproduction" appeared in 1910. The second, which was published in 1922, was described in these columns as the best treatise on the subject that we have. The reviewer went on to say that "it is because it is so good and so valuable that its beneficiaries are so concerned in its further development. It must remain the best book on the subject and a memorable contribution to British scientific literature". His hope has without doubt been realized in the third edition, now enlarged to three massive volumes, of which the first appeared in 1952, and the second is now under review. A third volume, dealing mainly with the male, is still to come.

The new edition is edited by Dr. A. S. Parkes and numbers among the contributors many of those who have been responsible for the advances that have been made since the second edition. Vol. 1, Part 1, which in spite of its numerical description has appeared after Vol. 2, contains two chapters con-

tributed by Dr. Marshall himself and in collaboration with Dr. Harrison Matthews. These give a general account of breeding periodicity and also describe cyclic changes in the lower vertebrates. About half the volume, by Dr. P. Eckstein and Sir Solly Zuckerman, is concerned with the morphology of the male and female non-pregnant reproductive tracts and provides a systematic account of the œstrous cycle in different groups of mammalia. Most of these chapters will be used for reference rather than read from beginning to end, and there is no doubt that students of reproduction will find them more up-to-date and comprehensive than any other statement about the topics with which they deal. The remaining chapter in this volume (by Prof. F. W. R. Brambell), which is concerned with the development of the ovary, the process of oogenesis, and the changes in the ovarian follicle during the course of the reproductive cycle, provides an excellent review of these perennially controversial matters.

The book remains unique for the reason that it supplies comprehensive and critical surveys of all aspects of the physiology of reproduction—something which no other single work attempts. In recent years fashion has tended to shift the focus of research to the chemical investigation of the sex hormones. Marshall's "Physiology", and especially this volume, is a reminder that, however eclectic the chemical story of reproduction becomes, its meaning is derived only from its relevance to biological phenomena, about which we understand very much more to-day than we did at the time when Dr. Marshall conceived of his gargantuan task.

P. L. KROHN

AN INDIAN HISTORY OF SCIENCE

Bijnaner Itihas (A History of Science)
In Bengali. By Sri Samarendranath Sen. Pp. xv+348+13 plates. (Calcutta: Indian Association for the Cultivation of Science, 1955.) 8*s*. Rs. 10.

THIS book is the first of a series which the author hopes to publish on the history of science. It takes the history from earliest times up to the Dark Ages in Europe and the end of ancient science. Although it is not the first book dealing with this subject to be written in an Indian language, it is certainly a far more serious attempt than any of its predecessors. As such it deserves to be considered from two points of view: that of its place in the literature of the history of science and that of its place in Indian writing.

From the former point of view it is evident that the author has drawn largely upon the writings of Sarton, Singer, Childe, etc. He frankly admits that his work is mainly based upon that of others, and reference to his bibliography will show that his sources are all in European languages. Any special interest which the book may hold for the European is thus likely to be on account of its taking a new approach to familiar problems. In fact, the author's breadth of vision is such that he rarely attempts to depart from accepted formulations, and only very rarely does his approach seem strange. It is when we consider the place of the book in Indian writing that its importance becomes apparent. The history of science is a very young child in Europe and America, but in India (at least in Indian languages) it owes its birth to Mr. Sen. Since India received independence, there has been an increasing expansion of education in the vernacular languages and a corresponding decline in the knowledge of English: this is only natural. At the same time, there has been an ever-increasing demand for technical and scientific education: if this demand is to be met, text-books will be required in the vernaculars. In view of the very wide attention which the history of science has recently attracted and of the growing belief that it is important for students of the humanities no less than students of science, the production of this book is an important landmark in Indian literature.

The plan of the book is simple. In the first chapter the author discusses the meaning of science and the relationship of science and society. He makes it clear that he is no adherent of the school which seeks a narrow fixed definition of the word and urges the need for progressive re-definition in dealing with different periods. He is also not prepared to adopt any extreme position in discussing the relationship of science and society. In the second chapter he draws upon archæological materials to outline the progress of man through the Old Stone Age and up to the Neolithic Revolution. In the third chapter the civilizations of the ancient river valleys are considered, together with the various branches of knowledge which then developed—writing, mathematics, medicine, etc. Here the author has made a bold but not altogether happy choice in describing the Indus civilization in more detail than those of Egypt and Mesopotamia. As our knowledge of the latter is so much greater and is aided by written sources, they appear inevitably to be more worthy of description. The next three chapters are devoted to an outline of Greek science from the beginnings down to the Alexandrians, the concluding two to Roman science and to the decline of ancient science and the causes for it.

We can only applaud this balanced and well-produced book, and look forward with interest to the further volumes the author has promised.

F. R. ALLCHIN

STRUCTURAL GEOLOGY

Structural Geology
By Prof. L. U. de Sitter. (McGraw-Hill Series in the Geological Sciences.) Pp. viii+552. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 67*s*. 6*d*.

THERE is no other book like this available in the English language; its appearance is as notable an event as was that of the "Einführung in die Geologie", by Hans Cloos, in 1936. The work is planned for a broad canvas, and details as well as the most prominent aspects have received careful treatment. Microstructures, minor folds, single mountains and great mountain systems are all grist to the mill. At the very least the book provides a convenient reference to an assemblage of world-wide, recent and sometimes rather inaccessible works upon most aspects of structural geology, and presents them with fair and fearless criticism; and what is much rarer, it risks a definite opinion upon most issues. But it

does more, for it presents the considered views upon the architecture of the Earth of an erudite, philosophical but still active field geologist. "As a field geologist", Prof. L. U. de Sitter writes, "I tend to believe what I see more than what I read", and his readers may think that they do too. Nevertheless, what he has written will stir up argument and shake up some time-honoured but not very sound opinions held by all varieties of geologists.

There are three parts. In the first the theory of strained materials is reviewed with more mathematical analysis than is usual in most geological literature. This may lead to some floundering in a morass of equations and may encourage the reader to pass on quickly to the account of models illustrating sundry structures, only to find that there are slippery patches here too. Distortion in oolites and other rocks, cleavage, schistosity and preferred orientation are dealt with in turn. Some space is devoted to the processes of compaction of loose and water-logged sediments showing how an unstable equilibrium may be disturbed and result in a sudden and catastrophical increase in fluid pressure. A similar process is considered later as a possible source of energy to set going magmatic intrusions. Part 2 records the results of stresses in the Earth's crust which lead to the suite of faults and folds that are familiar features in most mountain ranges. Complications which ensue when vertical uplifts affect the strongly folded rocks are referred to under the heading of gravitational gliding and collapse structures. It is argued also that the thickness of competent strata has an important part to play in setting up a pattern of folds and determining the size of individuals. Folds, once formed, are reluctant to give way to a new set of forces, but ideally they should, and cases are described where such things seem to have happened. The largest features on the Earth, like the Alpine and the circum-Pacific mountain chains, come in for discussion in Part 3. Magma is injected along such lines and helps in their formation, and is a clue to the course of events which took part in producing the complicated structures which are the final result. By contrast, the nature of the areas of unfolded rocks which appear within these great mountain chains is described.

To round off the book, Prof. de Sitter trails his coat by airing his views about a history of the Earth which he makes attractive by telling us of the youthful stage when, without a heavy core, convection currents within the Earth held sway and carried continents around the surface of the Earth. Growing older, its heavy core increased in size and obstructed these lively convection currents so that the continents came to rest a long time ago, during the pre-Cambrian in fact. Since then the Earth has been provided with permanent ocean basins and continents which have not changed their position essentially, although their margins have suffered some alteration through wear and tear, which is always taking place.

The book is deplorably edited. Slips in spelling abound. The inconsistent use of sometimes English and sometimes American words, and the invention of words that are not in the English language, like 'basculate', mar the presentation. The noun 'basin' is made to masquerade as a verb. Several diagrams are reduced too much, and some stand in need of more adequate explanation. The changes introduced into the sections shown through Iranian oilfields, Fig. 133, are so radical that the figure should not be printed as if it had the authority of the late G. M. Lees.

J. V. Harrison

FUNCTIONAL ANALYSIS

Functional Analysis

By Frigyes Riesz and Béla Sz.-Nagy. Translated from the Second French edition by Leo F. Boron. Pp. xii + 468. (London and Glasgow: Blackie and Son, Ltd., 1956.) 65*s*. net.

THE French version of this book, the first edition of which appeared in 1952, has already become widely known, and the English translation deserves the warmest of welcomes. The senior author, F. Riesz, who died earlier this year (see *Nature*, 177, 870; 1956), was one of the pioneers of functional analysis, and his collaborator, B. Sz.-Nagy, has made many valuable contributions to the subject.

The book opens with an exposition of Lebesgue integration, following a method devised by F. Riesz himself. The idea is to avoid any preliminary discussion of measure theory, the integral being defined first for step functions, and then for limits of monotone sequences of step functions. Once the principal properties of the integral have been established, the reader is introduced to some of the ideas of functional analysis, as they are exemplified in the L^p spaces; these include the Riesz–Fischer theorem, orthonormal systems, linear functionals, weak convergence and weak compactness. The Stieltjes integral is also treated.

Attention is next directed to the theory of linear integral equations. The method of approximation by kernels of finite rank, introduced by E. Schmidt and developed by J. Radon, is used to prove the theorems about the Fredholm alternative. After a brief account of the Fredholm determinants, the alternative theorems are proved again, the proof now being founded on the complete continuity of the integral operators; the whole Riesz–Schauder theory is thus obtained. The authors return to integral equations again later with the Hilbert–Schmidt theory of symmetric kernels, treated as a special case of the theory of completely continuous symmetric operators in Hilbert space.

Hilbert space theory is carried as far as the spectral theorem and the functional calculus for unbounded self-adjoint operators. Other topics treated are perturbations of the spectrum, the extension of symmetric operators, von Neumann's theory of spectral sets, groups of unitary and of self-adjoint operators, and the basic ergodic theorems. In Banach space theory the Hahn–Banach extension theorem and its consequences are discussed; the theory of semi-groups recently created by E. Hille and others is outlined; and there is a brief account of the spectral theory of F. Riesz and N. Dunford, where the resolvent of an operator is treated as an analytic function in the complex plane.

The aim of the authors is to introduce the reader step by step to the fundamental ideas of functional analysis, rather than to plunge him straight into an axiomatic account of its abstract logical structure; for example, the notion of linear functional appears in several concrete cases (the Hilbert space of functions of integrable square, the L^p spaces, the space of continuous functions) before the general definition for an abstract Banach space is given. There are numerous illustrative examples, which enable one to obtain a firm grasp of what the ideas mean and how they can be used. The book is extremely readable, and the translator has done his work well; anyone who wants to know what functional analysis is about would do well to begin here.

F. Smithies

Chemical Pilot Plant Practice

By Donald G. Jordan. (Chemical Engineering and Technology Library, Vol. 1.) Pp. viii+152. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1955.) 3.50 dollars.

THE opening chapter of this small book contains an interesting discussion of the general factors to be taken into account before building a pilot plant; these include, among others, cost estimation, the size and location of the plant, and the type of men required to operate it. It is also emphasized that pilot plants are not always required for checking and correcting the theories used for the design of full-scale plant, but may be used for small-scale production in order that the properties and commercial value of new materials may be studied and sufficient quantities of by-products may be obtained for the assessment of their utility. An analysis of the scale-up problem follows, and a chapter on the handling of materials on the pilot scale. In the next two chapters, various types of reactors and separation processes are discussed, and finally the important subjects of report writing and cost estimation are dealt with in detail.

Very little space is given up to theory, as it is assumed that readers are already conversant with the theoretical side; at the same time it would be unfair to describe the book as consisting of 'hints and tips'. Although these abound, they are presented as part of a reasoned discussion in which it is clear that the author is writing from practical experience. All who are concerned in any way with pilot plant are recommended to read this book, for very few will fail to derive some benefit from it.

H. E. WATSON

General School Physics

Heat and Light. By R. Stone, N. Bronner and J. Lawrence. (Grammar School Series.) Pp. ix+374. (London: English Universities Press, Ltd., 1955.) 9s. 6d.

WITH the senior science master of Manchester Grammar School as editor and part author, one former member of the staff collaborating, and another participating with advice, this excellent text-book for middle school use has the hall-mark of thoroughness and sound teaching that would be expected. It should help pupils to a real understanding of these parts of the subject, and stimulate their awareness of the application of physical principles in the world around them.

Mr. R. Stone's predecessor, the late H. S. Newbould, used to caution his younger colleagues not to try to teach too much; and there is always the temptation in elementary work to carry one's own interests to a level a little above the pupils' heads. Here the authors have not concealed their enthusiasm, but they have taken the greatest care to keep within the capacity of fifth-form boys in their explanations.

The diagrams, drawn with the clarity and simplicity of blackboard figures, are unusually good. In optics, great attention is given to ray diagrams, and this is clearly the method that the authors prefer at this stage for the solution of problems. Many teachers also may feel that algebraic formulæ are best deferred until a later stage, when they have to be repeated in any event; those addicted to their use will certainly approve the authors' analysis of the schoolboy's difficulties, and may find an answer to their own in the treatment advocated here.

G. R. NOAKES

Textile Testing

By James Lomax. Third edition. Pp. xiii+218+14 plates. (London and New York: Longmans, Green and Co., Ltd., 1956.) 30s. net.

THE arrangement and content of the third edition of this book are substantially the same as in the second edition. New material has been introduced in a few places in the text and, in seven pages of "additional notes", at the end. An introduction has been added. It is to be regretted that the author has not taken the opportunity of including descriptions of yarn-irregularity meters, methods of yarn inspection, or the newer automatic single-thread testers. Other important omissions are the use of the thread-crimp tester, the determination of threads per inch, cloth handle, creasability and tearing strength.

The author illustrates most of the calculations by examples worked out in detail. Such assistance is a luxury in a book of this kind. On the other hand, there is a lack of scientific and technological background, and of advice on the proper application of the methods described. In any future edition this balance should be corrected. British Standards Handbook No. 11 (to which the author frequently refers) now provides a manual for nearly all the routine work of a textile laboratory, and a modern text-book on textile testing could well be written with the aim of providing the basic information required to understand the techniques and apply them intelligently.

The book cannot be recommended unreservedly to a young student as his only guide because of a number of statements that are either inaccurate or inadequate.

H. M. TAYLOR

The Mechanical Properties of Textile Fibres

Edited by R. Meredith. (Deformation and Flow: Monographs on the Rheological Behaviour of Natural and Synthetic Products.) Pp. xii+333+4 plates. (Amsterdam: North-Holland Publishing Company, 1956.) n.p.

TEXTILE fibres are a class of technologically important materials with interesting mechanical properties: they are non-linear, strongly time-dependent and sensitive to humidity and temperature. Their various chemical structures, and the physical and chemical treatments they receive in processing and manufacture, result in many variations on the general pattern of behaviour.

Dr. R. Meredith and his co-authors Dr. L. Peters and Mr. H. J. Woods have written a welcome book in which they describe the mechanical properties of the various fibres and report the current position in the interpretation of those properties in relation to fibre structure. Cellulose, protein and synthetic fibres are discussed in separate sections which follow similar patterns for ease of cross-reference. There are chapters on structure, stress relaxation and creep, load-extension curves and on dynamic properties, each section ending with a chapter on properties which have received attention because of their practical importance: the strength of cellulose fibres, setting effects in keratin fibres, and resilience and creasing of synthetic fibres. Separate chapters are devoted to reaction-rate theory in two sections, and the theory of linear viscoelasticity is treated in connexion with stress relaxation and dynamic properties. There is a comprehensive bibliography.

IRRADIATION LABORATORY OF THE BRITISH INSULATED CALLENDER'S CABLES, LTD., RESEARCH ORGANIZATION

By Dr. R. M. BLACK

IT is now fairly well known that, when polymeric materials are exposed to high-energy radiation in atomic piles or from sources of beta- or gamma-radiation, they undergo profound changes in their physical properties. These changes are the result of a series of intermolecular reactions or rearrangements induced by the ionization and free-radical formation phenomena associated with the absorption of the radiation.

A study of the effects of irradiation of vinyl polymers and related hydrocarbons has shown that the radiation chemistry of the process involves a number of fundamental chemical changes: (*a*) formation of carbon-carbon bonds between the molecules accompanied by the liberation of hydrogen to give a three-dimensional polymer network; (*b*) formation and hydrogenation of carbon-carbon double bonds; (*c*) molecular degradation by fracture of the main polymer chain by a disproportionation reaction resulting in a product of lower average molecular weight; and (*d*) fracture of chemical bonds in the side-chains or branches of the polymer, with the production of low molecular weight hydrocarbons.

The balance between these reactions is not the same in all polymers and, in practice, it is found that either cross-linking or molecular degradation predominates, depending upon the molecular structure. Thus, dielectric materials can be classified into two categories: those in which cross-linking predominates (such as polyethylene, polystyrene, polyvinyl chloride and the silicones) and those in which degradation predominates (such as polyisobutylene, 'Perspex', polytetrafluoroethylene and cellulose). Some materials, by virtue of their chemical structure and the possibility of energy transfer and resonance effects, are more resistant to the effects of radiation than others. Polymers which contain aromatic side-chains (phenyl groups) are particularly resistant to radiation.

The behaviour of polymeric dielectric materials on irradiation is of interest for two main reasons. First, it may prove possible, by irradiation, to induce changes in the structure of the material which cannot be achieved by other methods and which will result in a product with improved properties. Second, if the material is to be used in a locality in which it will be subjected to constant irradiation, such as the biological shield of a nuclear reactor, the expected service life and a knowledge of the changes in electrical properties likely to take place are important considerations.

In order to investigate and, if possible, to exploit the properties produced in dielectric materials on irradiation, the Research Organization of British Insulated Callender's Cables, Ltd., has recently established an irradiation laboratory. This laboratory is equipped with a 2-million volt Van de Graaff electrostatic particle accelerator supplied by the High Voltage Engineering Corporation of Cambridge, Massachusetts, which serves as a versatile source of electrons, gamma- or X-rays, positive ions and neutrons. In addition, there is available a comprehensive radiochemical laboratory, equipped with a wide range of counting equipment and radioactive isotope sources, for the development of new techniques for testing and process control.

The Irradiation Laboratory is divided roughly into three parts by the central, two-story, radiation block. The latter consists of a target room on the ground floor with the generator room situated immediately above it. The walls of the target room are of concrete, 3 ft. in thickness, to prevent hazardous amounts of radiation entering the adjoining laboratories, and entrance to the room is by means of a safety door, connected to an interlock system, and a concrete labyrinth.

The target room is of sufficient size to enable a variety of irradiation experiments involving the use of conveyor belts and pulley systems, etc., to be carried out and, in addition, houses the pressurizing gas supply (carbon dioxide and nitrogen) for the generator.

The generator itself, which is designed to project a beam of electrons or positive ions vertically downwards, is installed in the room above, access to which is obtained by means of a spiral stairway from the target room. As the radiation intensity is consider-

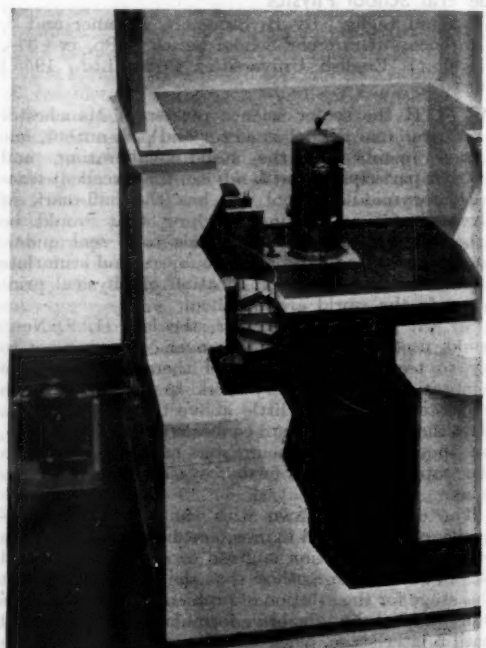

Fig. 1. Model of irradiation block, showing scanning assembly

Fig. 2. Scanning unit, showing the base of the generator with diffusion pump and vacuum system

ably lower than in the target room, the thickness of the generator room walls needs to be only 2 ft.

The water supply for the laboratories and for the generator is provided by two large tanks situated on the roof of the radiation block, and the necessary pressure for the cooling system of the Van de Graaff accelerator is obtained with boost pumps.

The generator block is flanked on both sides by laboratories which contain the control panels of the generator and various types of cable-handling machinery; and they are equipped for carrying out the various evaluation tests necessary and investigations upon the irradiated products.

Of the irradiated dielectric materials so far studied, one of the most interesting is polyethylene, as this polymer is cross-linked by high-energy radiation to give a polymer network which has a greatly reduced solubility in hydrocarbon solvents and which exhibits rubber-like elasticity at higher temperatures (greater than 115° C.) instead of melting. This elastic behaviour and non-flowing property at high temperatures would suggest that irradiated polyethylene has considerable possibilities as a high-temperature dielectric and, while the chemical changes accompanying the cross-linking tend to render the polymer more susceptible to thermal oxidation, investigation has shown that this can be reduced by the prior incorporation of a suitable antioxidant.

Radiation effects such as cross-linking and degradation are not, of course, limited to materials of high molecular weight. Hydrocarbons such as hexane and decane show a similar behaviour, and a study of simple materials is beginning to throw light upon some of the mechanisms of electrical breakdown phenomena. Similarities exist between radiation effects and the ionization effects which sometimes occur in high-voltage equipment under conditions of electrical stress. The well-known phenomenon of waxing or 'cheese' formation in some types of solid cable is only another form of cross-linking by electron bombardment, while the radio-oxidation which takes place during the irradiation of materials in the presence of air bears a direct relationship to the stress-ageing effects encountered in insulating oils contaminated with oxygen.

High-energy particle accelerators serve not only as a source of radiation for industrial processing but also as valuable laboratory tools for fundamental research. There is no doubt that the new techniques which have arisen during the development of atomic energy in the past ten years will find increasing application in the solving of technical problems which arise in the electrical industry.

PROPERTIES AND USES OF FERRITES

CONFERENCE IN LONDON

IT is difficult to-day to name a branch of the sciences or a field of industry or of human endeavour in which electronic devices play no part. During the past twenty-five years the electronics industry throughout the world has expanded at a very great rate, and new discoveries can be of major commercial value. It is not surprising, therefore, that reports ten years ago of the successful preparation of new magnetic materials with obvious applications in electronics and light electrical engineering were received with marked interest.

The use of ferromagnetic materials in coils and transformers had hitherto been restricted to the low-frequency region because of eddy-current losses in the metallic ferromagnetics available. Some improvement had been achieved by the use of fine metallic powders in a non-magnetic matrix—'dust cores'—but while eddy-current losses were thereby reduced, hysteresis losses were usually considerably increased. In 1946, some results were announced of work carried out under great difficulties at the Philips Laboratories in Holland during the German Occupation. The late Dr. J. L. Snoek and his colleagues had succeeded in preparing oxide materials with strong ferromagnetic properties, high electrical resistivity and low hysteresis loss. These materials were ferrites (in fact, mixed crystals of different ferrites) which had first been prepared by Hilpert in 1909; but Hilpert's materials, though ferromagnetic, had shown high losses in the presence of alternating magnetic fields and low permeability, and had no commercial value. Snoek's materials had considerable value and were soon made available commercially by Philips under the name of 'Ferroxcube'; later they were manufactured in the United States under the trade name 'Ferramic'.

The engineer was reasonably content, at first, to devote his skill and ingenuity to the use of the available materials, but the physicist and the physical chemist found much that was perplexing, particularly

in the magnetic behaviour of these new ferrites. Their chemical composition was known to be of the form MO, Fe_2O_3 where M is a divalent metal, and the crystal structure was that of the mineral spinel, $MgAl_2O_4$; but little else was certain. In 1948, a major contribution to the explanation of the magnetic properties came from Prof. L. Néel, who introduced the term 'ferrimagnetism' to describe these properties which he showed could arise from the subdivision of the magnetic moments in the material into two groups. In each group or sub-lattice, the moments were aligned parallel, as in ferromagnetic materials; but it was assumed that the moments of the two sub-lattices were oppositely directed, so that the observed macroscopic magnetic moment was not the sum of the individual moments, but the difference of the moments of the two groups of ions.

Since 1948, ferrites have been the subject of a vast amount of work, both on fundamental theory and experiment and in practical application; and so nearly a thousand scientists and engineers from more than a dozen countries gathered in London at the Institution of Electrical Engineers, during October 29–November 2, to review and to discuss some of the investigations.

In an introductory lecture the vice-president of the Institution, Dr. Willis Jackson, gave a detailed review of the development of ferrites up to the present date and surveyed the background to the conference. The meeting was thereafter divided into sections, each of which covered a different aspect of the very broad field of study. Each session of about two and a half hours followed roughly the same pattern. Pre-prints of the papers had previously been sent to those attending the conference, and authors were allowed merely a short time for the formal presentation of their work. The major part of each session was therefore available for general discussion, which was always interesting, sometimes stimulating and occasionally heated. It would not be feasible to comment upon all the papers presented or to attempt a résumé of the many discussions, particularly as two sections were often run concurrently during the last three days of the meeting. The subjects covered can best be outlined in general terms, and reference made to only a few contributors in each section.

Fundamental properties and processes in ferrites were discussed under Section *A*, which was subdivided into sessions on the preparation and general chemical and physical properties; magnetic spectra; molecular interactions; magnetic properties in steady and slowly varying fields; and the properties of new oxide magnetic materials. A review was given by A. J. E. Welch (Imperial College of Science and Technology, London) of the chemistry and crystal structure of ferrites and other magnetic oxides, while in the session on magnetic spectra J. K. Galt (Bell Telephone Laboratories) discussed the problem of losses in ferrites with particular reference to his examination of domain wall movements by the use of 'picture frame' single crystals in which a single wall was studied. The several earlier contributions made by G. T. Rado and his colleagues at the Naval Research Laboratory, Washington, D.C., to the study of the frequency-dependence of initial permeability were briefly summarized and extended in a paper on the effect of magneto-crystalline anisotropy upon the magnetic spectra of magnesium iron ferrites. R. Nathans (Brookhaven National Laboratory) reported the results of a neutron diffraction study of ferrites of the magnesium manganese system. Precise crystallographic data were obtained, including the distribution of the manganese ions between the tetrahedral and octahedral lattice sites. The power of this technique was very apparent, and it is to be hoped that similar investigations with other ferrite systems will be made.

The final session in this section included contributions by E. W. Gorter and his colleagues, of the Philips Laboratories, on oxide magnetic materials with hexagonal crystal structures, and by F. Bertaut and R. Pauthenet (Grenoble) on ferrimagnetics with the garnet structure having the general formula $5Fe_2O_3$–$3M_2O_3$.

It is significant that the second largest section of five sessions, with seventeen contributed papers, was that dealing with the theory and applications of ferrite materials at microwave frequencies. With the increasing importance of microwave techniques much effort has been devoted to measuring the properties of ferrites in wave-guide circuits and to finding, usually empirically, ferrite compositions with the most suitable properties for application in microwave components. What is the effect upon an electromagnetic wave in a guide when it meets a magnetic material that has a high dielectric constant (10–20) and a permeability which is, among other things, dependent upon the direction and magnitude of the applied magnetic field? Analytical solutions are usually reached only after great labour, and the papers in this section might be said, in general, to be contributions to the experimental answer to this question.

The section was opened with a paper by P. J. B. Clarricoats, A. G. Hayes (both of the General Electric Co., Ltd.) and A. F. Harvey (Radio Research Establishment, Malvern) which reviewed the general properties of ferrites at microwave frequencies and dealt briefly with the various types of components in which ferrites are used. A feature of the printed paper which many workers will appreciate is its extensive bibliography with 195 entries. The second session was devoted to microwave theory and measurements; it included contributions by I. G. Macbean (General Electric Co. Ltd.) and by R. A. Waldron (Marconi's Wireless Telegraph Co., Ltd.) on the measurements of permeability tensor components using resonant cavity techniques. Three sessions on microwave properties and applications followed. The Faraday rotation of the plane of polarization of an electromagnetic wave by a magnetized ferrite formed the basis of (*a*) the measurements reported by R. Derry and M. S. Wills (Royal Naval Scientific Service) using nickel ferrites and ferrite aluminates; (*b*) the rotation isolator described by P. E. Ljung (Sweden) for use in the 6 cm. wave-length region; (*c*) the isolator for the 8–9 mm. region produced by Dr. Elizabeth Laverick and Miss Ann Rivett-Carnac (Elliott Bros.); and (*d*) the 45° rotation isolator discussed by A. Langley Morris (Malvern). A. G. Fox reported on several of the current research projects of the Bell Telephone Laboratories, including the use of the permanent-magnet material 'Ferroxdure' (mainly $BaFe_{12}O_{19}$) for giving broad-band properties to a circulator used in the 3-cm. wave-length region.

Section *C* of the conference was devoted to the theory and application of ferrites which exhibit almost rectangular hysteresis loops. J. B. Goodenough (Lincoln Laboratory, Massachusetts Institute of Technology) examined the various factors influencing the shape of B/H loops, the coercivity and the

permeability of the materials, while O. Eckert (Germany) described the occurrence of constricted loops in ferrites containing cobalt oxide and showed the extent to which this property was affected by heat treatment in the presence of a magnetic field. Other contributors dealt with the applications of square-loop materials in digital computors ((B. Bambrough (Decca Radar) and W. Renwick (Cambridge)) and in data-handling systems (E. P. G. Wright (Standard Telecommunication Laboratories, Ltd.) and C. J. Quartly, A. L. Cain and R. W. Clarke (Mullard)), while W. Six and R. A. Koolhof (Philips) discussed the importance of the high-speed switching which can be carried out with ferrite materials, particularly when used in combination with transistors. Applications included electronically controlled telephone exchanges and an automatic reservation system for airline companies.

Section *D* of the conference was concerned with the application of ferrites to radio and television and included papers by R. H. C. Morgan (Mullard, Ltd.) and V. A. Jones and G. Campbell (Plessey Co.). Section *E* was devoted to carrier-frequency applications; in a review of the properties and general field of application to transformers and coils of high *Q*-factor and stability, W. F. Glover and S. E. Buckley (Standard Telephones and Cables, Ltd.) showed that ferrites can have distinct advantages over other materials at operating frequencies greater than 30 kc./s.

During the meeting there was an exhibition of some of the equipments and devices referred to briefly above. There were some thirty or forty exhibits, ranging from examples of ferrites fabricated into a wide variety of shapes and sizes through the often complicated wave-guide units involving ferrite isolators, attenuators, circulators and modulators to the simple ferrite rod aerial. To the worker in a limited field, the exhibition gave a rapid and striking picture of the wide range of application of the material the conference was discussing.

In the five days of the meeting nearly sixty papers were read which will be published with synopses of the discussions in the *Proceedings of the Institution of Electrical Engineers*, during 1957. The Institution is to be congratulated upon its decision to hold such a meeting. It was undoubtedly most successful and a tribute must be paid to its smooth and courteous organization; in particular, the strict adherence to the stated time schedule excited the admiration and envy of more than one of our overseas visitors.

It would be out of place for the writer of a review of this nature to comment critically upon any of the papers presented, but it is hoped that a general observation may be allowed. The number of scientists and engineers attending the meeting was striking testimony to the importance attached to ferrites. Although British workers were well represented as contributors in those sections dealing essentially in measurements and in applications using materials of the standard ferrite type, it does seem significant that, of the nineteen papers presented in Section *A*, only eight were from British workers and eleven, including most of those on fundamental processes and new materials, came from overseas visitors. Yet, as the conference made abundantly clear, there is much fundamental knowledge yet to be acquired.

K. J. Standley

DECAY OF PLANT LITTER

In opening the series of papers under this title at a joint session on August 31 of Section K (Botany) and Section K* (Forestry) at the meeting of the British Association at Sheffield, Dr. J. G. Boswell described observation which had been made on the chemistry and microbiology of some natural soils in the neighbourhood of Sheffield and on similar soils in northern England and southern Scotland. The local areas included the Ringinglow Bog, the surface vegetation of which is largely *Eriophorum* spp., Lady Canning's Plantation containing *Pinus sylvestris* and *Sorbus aucuparia* with *Deschampsia flexuosa* and *Galium saxatile* in the field layer, and Ladies Spring Wood with *Quercus petraea* and *Betula pubescens*. Fractionation with solvents showed that the lignocellulose residue from the peat of Ringinglow Bog contained 25 per cent of the total acidity and in the form of strong acids. The humus from the podsol of Lady Canning's Plantation had a lower total acidity than that of the *Eriophorum* bog in spite of a lower *p*H value, and 55 per cent of the total acidity was located as strong acids in the ligno-cellulose complex.

Microbiological examination showed that there existed in all the soils a group of active protein decomposers, but that from Ringinglow Bog nitrifiers and nitrogen fixers were never isolated. The soluble nitrogen present in this soil was in the form of ammonia, and this was a limiting factor in cellulose decomposition by fungi since while species of a number of genera, *Cephalosporium*, *Pullularia*, *Cladosporium*, *Trichoderma*, *Aspergillus* and *Penicillium*, were isolated, those which in pure culture would decompose cellulose did so only when nitrogen was supplied in the form of nitrate. The humus layer from Lady Canning's Plantation contained a number of sugar-fermenting bacteria of which the most important was a species of *Clostridium* which fixed nitrogen in pure culture, the activity being confirmed by the use of nitrogen-15. Four genera of fungi capable of decomposing cellulose were isolated, of which a species of *Aspergillus* was by far the most active.

Dr. Scurfield had examined the distribution of *Holcus mollis* and *D. flexuosa* in Ladies Spring Wood in relation to the structure of the soil profile. C/N and C/O ratios of the horizons of the profiles showed that with increasing depth, the residue under *D. flexuosa* becomes poorer in nitrogen although with an unchanged oxygen content, while under *H. mollis* the residue becomes progressively richer in both nitrogen and oxygen. The *D. flexuosa* profile contains nitrogen only in the form of ammonia, but under *H. mollis* both ammonia and nitrate are present. This, together with the facts that nitrogen-fixing bacteria appear to be more abundant under *H. mollis* than under *D. flexuosa* and that the plants of the former have a nitrogen content about 50 per cent greater than those of the latter, suggests that nitrogen relationships are an important factor in profile development.

The wide survey of soils from the northern parts of Britain amplified the observations recorded above. Further correlations were made between the E_s potential of the soil, the activities of the nitrifiers

and cellulose-decomposing bacteria, and the nature of the surface vegetation. A very widespread distribution of the nitrogen-fixing species of *Clostridium* was found.

Dr. J. Webster read a paper entitled "The Grass withereth". He pointed out that although the process of decay had hitherto been extensively studied in soil and composts, there was little published information on the succession of organisms which colonize plant remains before they are incorporated into the soil. The colonization of flowering stems of cocksfoot (*Dactylis glomerata*) by fungi was described. About two hundred species of saprophytic fungi had been collected on cocksfoot in three localities near Sheffield. Among the more common fungi found were: (1) *Cladosporium herbarum*, *Epicoccum purpurascens*, *Alternaria tenuis*, *Leptosphaeria microscopica* and *Pleospora vagans*, which were among the first fungi to fruit on moribund tissues. Although present for a limited period on lower internodes, they only persisted for long periods (up to a year) on the upper internodes. (2) *Leptosphaeria nigrans* and *Mollisia palustris* formed fruit bodies on the basal internodes within the tussock during the summer following flowering. (3) *Helminthosporium hyalospermum* and *Tetraploa aristata* also appeared at the tussock base with *L. nigrans* and *M. palustris*, but continued to fruit throughout the following winter and the second summer after flowering on collapsed stems. (4) *Acrothecium* sp.: confined to the lower internodes during the first few months following flowering. (5) *Selenophoma donacis* and *Mycosphaerella recucita* fruited on the upper internodes during the summer following flowering. These fungi were common on other grasses, and work by Mr. H. J. Hudson has shown that on *Agropyron repens* their distribution paralleled that on cocksfoot. Isolations from *Agropyron* stems also showed that the distribution of the mycelium of these fungi resembled closely the distribution of fruit bodies.

In analysing the distribution patterns further, evidence was presented that the water content of the stems was an important factor controlling distribution. Determinations of the water content (as percentage dry weight) showed that the value for the upper internodes frequently fell below 15 per cent, which was probably a limiting value for mycelial growth, while the value for lower internodes was consistently high. The water-content gradient could be destroyed by cutting stems down and placing them on the ground. This results in an upward spread of fungi in groups 2, 3 and 4 (above), and a more rapid disappearance of fungi in group 1. There was evidence, however, that other factors were important.

Dr. P. W. Murphy described the role of "Soil Acarina" in the decomposition of leaf litter. The organic detritus of the forest floor consists of stems, branches, roots, bark, fruits and seeds together with the remains of shrubby and herbaceous vegetation. The Acarina often occur in large numbers in these remains, and field observations and culture experiments have shown that certain mite species, especially the Oribatoidea, feed on leaf litter. In laboratory cultures the amount of leaf material ingested is dependent upon tree species, moisture content of the leaves and certain unknown factors, some of which may be concerned with the microfloral and microfaunal populations of the litter. Concerning the first, it is known that certain plant species show well-marked tendencies to form mull or mor, and the leaf comminuters among the fauna show a preference for mull-forming plants. For example, when cultures of *Steganacarus magnus* (Nic.) are provided with *Fraxinus*, *Betula*, *Pseudotsuga taxifolia* (Poir) and *Pinus sylvestris* L., a series chosen to represent broad-leaf and conifer species which have reputations for 'rapid' and 'slow' decomposition respectively, a definite preference is shown for broadleaf as opposed to conifer litter, and ash to birch. An exception to the above situation was found in the case of *Nothrus sylvestris* Nic. cultured on *Calluna vulgaris* Salisb. and *Picea sitchensis* Trautv. and Meyer, when there was very little difference in preference, and quite large quantities of *Calluna* were ingested. This result is rather unexpected in view of the nature of *Calluna* litter, and the length of time it remains apparently little altered under natural conditions. The reasons for these preferences are not at present clear, but there is some evidence that the physical properties of the litter are of importance.

At present little is known about the metabolism of these creatures, and thus the chemical changes taking place during the passage of leaf material through the gut. The average size of the leaf particles in the excrement was about $5\mu \times 3\mu$, and it is evident that apart from any chemical transformations the part played by these mites in the physical disintegration and comminution of the leaf litter is of a high order.

The excrement is deposited usually in the form of round or cylindrical pellets, and it is probable that they provide sites for further decomposition by plants and animals. With certain 'humus forms', moder, for example, these pellets are very numerous, and indeed in the *H* layer of protorendzina soils practically all the organic matter may be present in this form. In mull soils, on the other hand, although mites may be very numerous, the amount of recognizable excrement elements is not great, and it is likely that the further decomposition stages are much more rapid under these conditions.

Dr. J. D. Ovington read a paper on "The Importance of Litter Breakdown in the Woodland Ecosystem". The formation of a surface layer of organic material is a characteristic feature of many British woodlands. In some woodlands, particularly of hardwoods, the litter may almost completely disappear before the next leaf-fall; in others, usually but not always conifers, the litter forms a permanent cover over the mineral soil. The amount and type of humus formed varies considerably, depending upon many factors, and has been regarded as an indication of the ecological status of the woodland, particularly from the point of view of nutrient supply and biological activity.

The litter is derived from a variety of sources, for example, from the tree canopies and roots, from the associated shrubs and ground flora and from the forest animals. Because of the dynamic nature of the woodland ecosystem the relative amounts of litter contributed by each of these may vary considerably from woodland to woodland and also at different stages of development of the same woodland.

From studies in an age series of Forestry Commission plantations of *Pinus sylvestris* grown at Thetford Chase, it has been possible to determine the annual fall of litter from the trees as cone, branch and leaf material. At forty-seven years of age the litter fall from the trees is about 5,000 kgm. of oven-dry matter per hectare or about twice the total weight

of litter over the forest floor. When heavy thinning and pruning take place the annual deposition of litter may increase to 15,000 kgm. of dry matter per hectare and branch material forms a much greater proportion of the litter. In all, the total oven-dry weight of litter falling from the crop of *Pinus sylvestris* during fifty-five years of afforestation is approximately 300,000 kgm. per hectare, about half of this being leaf material.

The contribution of the ground flora to litter formation varies considerably, depending upon the density and nature of the tree crop. In old plantations the ground flora may be heavier than the weight of leaf carried on the trees, so that the death of the shoots of the associated herbs results in a significant annual contribution to litter formation.

Considerable amounts of plant nutrients are contained in the organic matter falling each year in woodlands. Since the accumulation of litter after forty-seven years of afforestation with *Pinus sylvestris* only equals the litter fall for two average years, it is evident that a large proportion of the plant nutrients has been released into the ecosystem by the decomposition of the litter. The release and circulation of plant nutrients may be much greater in an actively growing woodland with a mor humus layer than in a slower growing woodland having a mull humus. A more dynamic approach to litter formation in woodlands by studying the diverse aspects of nutrient turn-over is needed and should be closely linked with the biological activity of the micro-flora and fauna.

J. G. Boswell

VIGILANCE

A SYMPOSIUM on "Vigilance—the Nature of Alertness and the Problem of its Maintenance during Long Spells of Work" was held by Section J (Psychology) of the British Association during the recent meeting there. Dr. N. H. Mackworth (Medical Research Council Applied Psychology Research Unit), the opening speaker, defined vigilance as a state of readiness to detect and respond to certain specified small changes, occurring at random time-intervals, in the external environment. In real life, the problem was to discover why people failed to notice and act on a signal which they were normally quite able to detect. Although they knew what they were looking for, they did not know when to expect this signal. Experimentally it had become customary to measure inspection performance by considering (1) the average number of signals neglected over a given period, or (2) the intensity to which a given signal had to be raised before it was reported.

The main factors in vigilance were either environmental or motivational. The environmental factors included the work situation as well as the general surroundings.

The environmental variables in the work situation were mostly concerned with the dimension of time. For example, Deese[1] had demonstrated how the probability of detection depended on the frequency of signals per hour. Baker[2] had shown that the uneven spacing of signals along the time scale was of even greater importance. This unpredictability in time was thought to carry more weight than any other single environmental factor in causing a loss of alertness during prolonged work. Long working spells were known to be a further factor; Wyatt[3] had demonstrated this in industry, as had Mackworth[4], Broadbent[5], Baker[2], Whittenburg and others[6], and Adams[7] in the laboratory. According to circumstances, alertness began to deteriorate anywhere between a few minutes to one hour from the start of the spell, but usually about half an hour from the beginning. The duration of the signals was also of importance in some cases[7]; but Saldanha[8] had demonstrated that there could be a marked decline in accuracy of response even when the signal remained available until response was made. Aspects of the working situation not yet studied in any detail were the possible effects on alertness of having to neglect many unwanted signals. Regularity in the temporal spacing of wanted signals helped performance; but perhaps regularity in the unwanted signals might hinder it. Little was also known about the effects of systematically increasing the frequency of unwanted events.

The environmental factors in the general surroundings that reduced watchfulness were continuous noise[9], high atmospheric temperatures[10] and isolation[11].

The motivational variables were less clear although of equal importance; the increased motivation of immediate knowledge of results could keep vigilance at its initial level for two hours[4]. Reducing motivation by lack of sleep gave a marked increase in the number of unreported signals during a 45-min. test[12].

Mr. E. Elliott (Admiralty Research Laboratory) discussed the change of the effective threshold during the day. The classical threshold for detecting a stimulus was the level at which the stimulus was detected on half the presentations, but this assumed the optimal conditions of expectancy and perception. In real life, such optimal conditions were not present and men did not detect the stimulus at the classical level but at some higher level which could be called the effective threshold. This was measured by giving the subject at random intervals an auditory signal the strength of which was equal to the classical threshold for that subject. The effective threshold was regarded as zero decibels if the subject gave a response at that level. If he did not detect this signal it was repeated about 30 seconds later one decibel louder than the classical level. If still undetected, the signal was repeated after about the same time-interval two decibels above the classical level, and so on until the signal was detected and reported by a key being pressed. The effective threshold was the amount the signal had to be increased above the classical threshold for detection.

This ascending series was given at intervals about ten times during the two-hour test. This technique was used for examining effective auditory thresholds in six subjects tested daily for three weeks. In the morning they were given ten measurements of effective thresholds in two hours, and in the afternoon they were given ten signals per minute each 1 decibel above threshold. The average effective threshold was found to be about 4 db. above the classical threshold; 10 per cent of the time it was

less than 1 db.; but 10 per cent of the time it would exceed 8 db. It was found that there was a large improvement in the effective thresholds for each subject (as measured in the morning) as time went on, but the improvement did not affect the 5–10 per cent period during which effective thresholds were 8 db. or worse.

Other subjects were first tested only by the morning procedure and then the faster presentation of the afternoon was added later. This improvement in the morning results seemed to depend on the presence of the afternoon tests, suggesting a transfer effect. However, the commissive error rate was roughly doubled by the introduction of the afternoon sessions. In fact, the subjects were trained by the frequent but weak signals of the afternoon to listen down to the noise itself.

Thus when a high probability of detection of a signal in noise was required, a high commissive error rate should be encouraged. But the really serious problems of vigilance were related to the larger peaks in effective threshold curves, when the signal strength had to be 8 db. or more above the classical threshold to be detected. These peaks could lead to very expensive mistakes and dangerous accidents.

When a man was asked to do a vigilance task, he had to stop his normal behaviour of scanning rapidly from one set of stimuli to another and concentrate on one set only. It was desirable that his effective threshold for these stimuli should be very low, although his natural living threshold might be very high. It was therefore necessary to study normal vigilant behaviour outside formal test periods.

Mr. D. E. Broadbent (Medical Research Council Applied Psychology Research Unit) discussed the relation between the failures of the vigilant man who was only watching for an occasional signal to which he had to react, and those of the active man who was keeping up a steady stream of activity which had to be related to random changes in his environment. There was considerable evidence that failures in perception could occur with the active job just as with the passive one, and lead to poor performance or accidents. For example, the studies by Saldanha[8] had demonstrated that in accurately setting a Vernier gauge by means of a small handwheel, less accurate settings were being accepted after only 15 min. The accuracy with which a man could keep a pointer on a mark by turning a handle at a constant speed had been investigated by Siddall and Anderson[13]. Again, the errors became greater as time went on. In both these active tasks there was deterioration in performance, just as there was in the passive vigilance tasks.

Other workers had also shown that continuous activity did not maintain alertness in a passive vigilance task. Moreover, Adams[14] had reported that a rest pause was not so helpful to performance at an active task when the rest was spent watching someone else do the work, as when it was taken right away from the work.

It was therefore clear that failure of observation was an important element in active as well as in passive tasks. This suggested that active tasks could be usefully employed to study perceptual failure. In self-paced tasks the speed of response to a signal depended on the probability of that signal. Although the average rate of work might remain the same, there might be an increased unevenness in response shown by pauses and spurts in the activity. It seemed likely that these irregularities in performance represented fluctuations in perception and that similar fluctuations might occur in a pure vigilance task. A brief signal might occur during a brief failure of attention and therefore be missed. If, however, the signal were prolonged or repeated it would exceed the moment of failure and so be detected.

In addition to its considerable theoretical interest, vigilance was also of great practical importance, particularly as regards accident prevention.

Dr. D. H. Irvine (Army Operational Research Group) discussed vigilance in industry in relation to machine-minding and to inspection tasks, and also touched on the reliability of clinical judgments. He pointed out that the signal to be identified might be very brief, or machine paced, or it might persist until attention was paid to it. In the latter case, the signal might become more urgent as time went on, as with the warning light indicating to a motorist that his oil was low, or it might remain static, as with many inspection tasks, where the operator could take his own time to decide whether each item was faulty or not.

Inspection tasks might involve a yes/no decision, where the faulty item had to be identified and rejected, or they might involve grading into classes, or finally, they might involve accurate determinations of measurements along an apparently continuous scale. This visual inspection was affected by factors of vigilance, subjective judgments and decision taking.

Several experiments had been carried out on the variations of subjective judgments between one person and another, even when these people were experts in their own field. Moreover, they varied widely in their judgments on the same materials repeated on two successive occasions. Many of these experiments concerned clinical judgments of disease, since this was a field where the single opinion of an expert could be vitally important. This variability in diagnosis had been extensively surveyed in the examination of X-rays by experts[15–17]; the experimenters found that the use of standards reduced the variability, and that reduction of the number of possible categories also improved consistency. They recommended that for anything as important as a medical opinion at least two examinations of the material should be employed.

One of the major difficulties in investigation of inspection work in industry was the difficulty of finding out how many potential rejects were missed by the operator. Dr. Irvine had carried out an experiment in which subjects were asked to grade pharmaceutical ampoules, first for impurities, and secondly by the nature of the impurities, and each subject graded the ampoules four times, while the batch of 200 ampoules was graded by 24 different subjects, and also 32 times by the author. There was considerable variability in the grading, but it appeared that accuracy of grading improved as the results for many inspections were pooled. As with the clinical material, where high accuracy was essential, it appeared that the same material should be examined several times, if possible by several people.

This experiment also showed that the rejection-rate depended on the batch size; that is, a higher rejection-rate was obtained when the material was examined in two sessions of approximately half an hour each, than when it was all examined in one session. There was no correlation between the time

each person took to complete the examination and the reject rate.

Mr. D. Wallis (Admiralty) emphasized some of the more important aspects of the papers. He pointed out that when signal frequency was increased, performance was improved in terms of probability of detection; indeed, the percentage success rose from about 40 to 90 per cent. But the absolute number of signals missed remained about the same, that is, 4 per hour, in the experiment under discussion[1]. Thus, if missing a signal was due to a fluctuation of attention, then these brief but serious lapses might be thought to occur at the same rate whatever the speed of signal presentation.

Mr. Wallis also saw a wide application of the technique described by Mr. Elliott, as this enabled an investigator to sample the precise level of vigilance throughout lengthy periods.

Among the various methods of improving performance in vigilance or inspection tasks the most effective in practice was the use of two operators at the same time, since the lapses suffered by two individuals were uncorrelated in time. In a recent study, Mr. Wallis had found that detection probabilities could be doubled by this approach. There was also the possibility of transfer from tasks specially designed to maintain vigilance to the actual task. Finally, there was the possibility that some people who liked to be quiet and alone might be better at vigilance tasks that require this than would more extroverted people.

Dr. P. Bakan (U.S. National Science Foundation) discussed his experiments on vigilance[18]. The occurrence of performance decrement over time was a result of an increase in the effective threshold for the discrimination required for the task. Repeated effective threshold measurements for the detection of occasional brighter flashes had shown that the required increase in intensity had to be raised after 15 min. Variables related to sleep were also related to a loss of vigilance in performance tasks. Monotonous environments might produce either of these states, while amphetamine sulphate could counteract them. Moreover, physiological changes such as electroencephalogram changes and reduction of muscle potentials were common to both states. However, the subject in a vigilance task would usually make efforts to keep awake by self-generated stimuli, for example, the characteristic increase in restlessness, singing or day-dreaming. It was important also for the experimenter to try to raise vigilance by introducing external stimuli in order to avoid a state of sensory deprivation[19]. Such external stimulation could be irrelevant to the particular vigilance task, yet had to be compatible with it.

Mr. D. C. Fraser (Institute of Aviation Medicine) said that three conditions were needed in a vigilance task: (1) the presence of neutral signals which had to be disregarded but throughout which the significant signals were randomly interspersed; (2) stress conditions were also required in terms of speed, load, duration, etc.; (3) knowledge of results had to be minimal. Tests of effective threshold were therefore of a different nature from the classical vigilance test. Two kinds of vigilance had been found, the alertness needed throughout a long test to detect the occasional significant signals among many other slowly presented signals, and that needed in a short test for detecting the occasional signal among many rapid neutral signals.

Actual sampling during the work itself was even more promising than effective threshold techniques. Recent experiments at Farnborough had shown that vigilance fell off after 40 min.—which was very close to the earlier findings[4].

A full study was now needed of the relationships between vigilant behaviour and neurophysiological measures. The chairman of the meeting (Prof. J. Drever) had developed electroencephalogram techniques which Mr. Fraser suggested should be used to detect changes in the neurophysiological pattern during vigilance tasks.

N. H. MACKWORTH

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OBITUARIES

Dr. H. R. Kraybill

HENRY REIST KRAYBILL, who died in Chicago on September 30 at the age of sixty-five after several months illness, was particularly well known for his research studies on meat and meat products over the past fifteen years.

After graduating in agricultural chemistry at Pennsylvania State College in 1913, Dr. Kraybill took his doctorate at the University of Chicago in 1917. He organized and developed the Departments of Agricultural Chemistry first in the University of New Hampshire from 1919 until 1924 and then in the Purdue University from 1926 until 1941. During this period, he also served as State chemist for New Hampshire and Indiana and held appointments at the Boyce Thompson Institute and the United States Department of Agriculture.

He returned to Chicago in 1941 as director of the Department of Scientific Research of the American Meat Institute and as professorial lecturer in the

Department of Biochemistry at the University of Chicago. When the American Meat Institute Foundation was formed in 1947, it was a natural consequence that he should become its first director of research and education. In 1955 he became in addition vice-president of the research organization of the Institute. At different periods, he held office as president of the Association of Agricultural Chemists, the American Association of Feed Control Officials, and the American Society of Plant Physiologists, and as chairman of the Division of Agricultural and Food Chemistry of the American Chemical Society.

From his earlier work in the fields of plant biochemistry and physiology, Kraybill turned in 1941 to pioneer work in the chemistry of meat and meat products. One of his most important contributions in this field was the discovery and development of two antioxidants for animal fats which not only inhibited development of oxidative rancidity in the fat alone but also inhibited the development of rancidity in manufactured products containing the fat. He learned just before his death that for this work he had been chosen for the Dodge and Olcott Award for 1956.

Earlier in the year, the Purdue University had conferred on him an honorary degree of doctor of science in recognition of his service to the University and his achievements as a scientist, teacher and administrator in the science of agriculture.

Dr. Kraybill was of a quiet, retiring disposition and always gave a very warm welcome to visitors from Britain to the United States. J. G. SHARP

Prof. James M. Sherman

PROF. JAMES M. SHERMAN, professor of bacteriology in Cornell University since 1923 and head of the University's Department of Dairy Industry, died on November 5 at the age of sixty-six. He had relinquished his administrative duties as departmental head on July 1, 1955, in order to devote his full time to writing and research.

Prof. Sherman was a graduate of the North Carolina State College and the University of Wisconsin. Before going to Cornell, he held teaching posts in the University of Wisconsin and Pennsylvania State University, and he was bacteriologist in the U.S. Department of Agriculture during 1917–23. He was a past-president of the American Dairy Science Association and of the Society of American Bacteriologists.

Prof. Sherman was the author of more than a hundred research papers, and published a book on laboratory methods in bacteriology and a monograph on the streptococci. His major research work concerned general biological studies of micro-organisms, systematic studies of some of the important groups of bacteria, especially the streptococci, and investigations of the micro-organisms of importance in milk, food products, soil and industrial fermentations. He served as editor-in-chief of the *Journal of Bacteriology* (1944–51), and associate editor of the *Bacteriological Reviews* (1937–44), and at the time of his death he was a member of the editorial committee of the "Annual Review of Microbiology".

NEWS and VIEWS

Agriculture in the University of Melbourne: Sir Samuel Wadham

SIR SAMUEL WADHAM retires at the end of 1956 from the chair of agriculture in the University of Melbourne after thirty years in that position. Sir Samuel took his first degree at Cambridge (Christ's College), and after the First World War, when he served in the Middle East, he returned to Cambridge as a senior demonstrator in botany. He was invited in 1926 to go to Melbourne as the first professor in a reorganized Department of Agriculture. During his occupancy of the chair some four hundred students have taken their degrees (B.Agr.Sc.), and his graduates comprise a hundred of the scientific staff of the Victorian Department of Agriculture. His own career has been especially marked by the calls that have been made by governments on his skilled services as an adviser in the field of land utilization; in particular, he played a major part in two Commonwealth Commissions, one into the wheat, flour and bread industries during the mid-1930's, and the other the Rural Reconstruction Commission, 1943–45, which advised on policies of post-war land settlement. The chief lines of work carried out in the School under his direction and stimulus have been surveys of soil and land utilization and standards of living. His "Land Utilization in Australia", first produced in 1939 in collaboration with Prof. G. L. Wood, has become an accepted text-book, and is now in its third edition. Apart from his work for agriculture, Sir Samuel has played a major part as a university administrator and in interpreting the university to the public. Through personal visits and regular broadcasts he has become widely known and loved throughout the Australian agricultural community. His exceptional services to Australia were recognized by the award of a knighthood in the New Year Honours in 1956.

Dr. H. C. Forster

DR. H. C. FORSTER, who succeeds to the Melbourne chair of agriculture, is a graduate of the school of which he now becomes the head. His published work deals with factors determining the yield of wheat, and his degree of Ph.D. in statistics was taken at the University of Iowa during the tenure of a Commonwealth Fund Fellowship in 1935–37. He first joined the Victorian Department of Agriculture, in which he became senior cereal research officer, and for many years he has been a part-time lecturer on cereal crops in the University's School of Agriculture. He was president of the Australian Institute of Agricultural Science in 1955, and chairman of the central executive of War Agricultural Committees during the Second World War. Since 1949 he has been assistant executive officer of the Commonwealth Scientific and Industrial Research Organization. He brings to his new post an exceptionally wide knowledge of agriculture and agricultural research throughout the Commonwealth.

Awards for University Education

IN a debate in the House of Commons on November 29 on university awards, Mr. J. C. Jennings, Mr. F. Mulley and Lord Balniel pressed for the establishment of a working party to examine the

possibilities of a central award-giving body, and to advise the Minister in connexion with the forthcoming triennial review of awards. Mr. B. Vosper, Parliamentary Secretary to the Ministry of Education, declined to commit himself, but agreed that the problem is due for review. He said that the Minister is considering the probable effect of the projected university expansion on awards policy, but he sees no reason why the system of awards should fail to meet the proposed expansion, and he accepts the view that our policy should be to ensure that young persons desiring and capable of receiving university education should not be deprived of it. In 1955, he pointed out, 15,900 of the 18,000 United Kingdom students entering the English and Welsh universities held Ministry or local authority awards, and of these, 12,500 held local authority awards, an increase of 25 per cent on the figures for 1951. Moreover, every local authority has now come into line so far as awards and the basis of assessment are concerned, and there has been a considerable advance towards uniformity in vacation allowances and like matters. Complete uniformity has also been secured in regard to consideration of candidates with two passes in the General Certificate Examination at the advanced level.

Scientific and Technical Co-operation in Africa

An admirable record of scientific and technical co-operation has been issued by the Commission for Technical Co-operation in Africa South of the Sahara and by the Scientific Council for Africa South of the Sahara, the secretariats of which were amalgamated on January 1, 1955, to ensure maximum co-ordination between two complementary organizations. In 1955 the Commission extended its inter-African consultations to include the social sciences and convened the first meeting of the Inter-African Conference on the Mechanization of Agriculture as well as scientific meetings on the control of quelea birds and the use of irrigation water in drainage and agriculture. Recommendations have been submitted to member governments which may lead to the adoption of a standard system of meteorological and climatological data for the African continent, while studies have continued on strictly regional problems in soil conservation, land utilization and the scientific aspects of geology. The work of the two organizations to 1955 is reviewed in a series of chapters covering pedology, agriculture and forestry; meteorology, climatology, irrigation and drainage; physical hydrology; animal resources; protection of natural resources and of agricultural production; geology; cartographic and statistical data; co-operation in the field of health; inter-African co-operation in social welfare and education; inter-African co-operation in the field of labour; joint action in the social sciences. They show that the activities of the Commission and of the Council now cover practically the whole scientific and technical field, while international contacts are also being widened. Chronological extracts from the annual reports of the Scientific Council for Africa, 1949–55, and from the technical conferences held under the ægis of the Commission, 1948–55, are also included, and there is a general index.

Life-History of the Desert Locust

"The Ruthless One", a new film on the desert locust made by the Shell Petroleum Co., Ltd., succeeds in the short screen time of 18 min. in being equally interesting to the lay viewer and to the advanced student and teacher. The life-history of the desert locust is splendidly shown in colour, with close-up sequences of mating and egg-laying, and all stages of growth from the new hatchling to the winged adult. Since no amount of patient preparation can ensure demonstration of these processes on living material, this cannot fail to be of value to teachers. The nature and size of the locust problem are illustrated briefly, and some sequences made in the Anti-Locust Research Centre in London show the work of that organization, particularly in the collection and dissemination of information. Some shots show research in the laboratory and in wind tunnels. With commendable self-effacement, the film does not deal at length with the practical achievements in field-methods of locust control. Scientists are inevitably divided in their attitude to all steps at popularization. The slightly melodramatic title is explained as a translation of *Al Garad*, one of the Arabic names given to the locust. Then the question of musical background: Can the public never absorb information without it? However, it is well-composed music and anyone who has enjoyed, say, "Peter and the Wolf", will enjoy the background to the courtship scene. Issued in conjunction with the film is an illustrated booklet, "The Hungry Thief"; this will help the layman—and perhaps the administrator—to understand the recent progress made in the locust problem.

A New Reactor Course at Harwell

New opportunities for industry to acquire basic knowledge of nuclear energy are offered by a special course which has been arranged at the Harwell Reactor School. The standard Reactor School course is one of fourteen weeks duration, giving instruction primarily in reactor physics and engineering. Present arrangements enable some students to attend only the first six weeks of this course, during which time the basic principles of these subjects are taught; but the numbers of these students have had to be limited because the demand for places on the standard course has been high.

During June 3–July 12, 1957, a special six weeks course is to be run entirely separately, and some sixty places will be available. Besides covering the basic principles of the physics and engineering of reactors, lectures will be given on such subjects as reactor metallurgy, shielding and health physics. In addition, emphasis will be placed on special topics such as the instrumentation of reactors and the use of radioisotopes in industry. This special course is designed primarily for people of degree standard who are not directly concerned with overall reactor design. It should appeal especially to members of firms whose interest lies in the making of ancillary equipment for reactors. Application forms can be obtained from the Reactor School, Atomic Energy Research Establishment, Harwell, Berkshire.

Conference of Farm Historians

Sir James Scott Watson took the chair at the winter conference of the British Agricultural History Society held in December in co-operation with the Association of Agriculture at the Institute of Education, University of London. The conference listened to three papers: one by Mr. F. C. Payne, of the Welsh Folk Museum, St. Fagans, on "The Plough in Britain", and a second by Miss E. M. Marston, lecturer in horticulture at the University of Nottingham, on

"The History of Plant Propagation in England". The third was by Mr. G. E. Fussell, on "The Grasses and Grassland Cultivation, 1500–1900".

All three papers were devoted to some aspect of the history of farming technique, and this is in accordance with the policy of the Society. At the annual conference normally held at the end of April, papers on local history or on some aspect of economic or social history are presented. If local, the lecturers usually try to deal with the neighbourhood in which the conference is held. At the winter conference in December, papers on technical history are read. Papers read at the conferences are not necessarily printed in the *Agricultural History Review*, which is published by the Society and distributed free to members. It appears twice a year and includes notes, original papers and book reviews. It can also be purchased by non-members. The honorary secretary, Mr. J. W. Y. Higgs, Museum of English Rural Life, 7 Shinfield Road, Reading, will welcome inquiries from anyone interested.

Toxic Hazards of Pesticides to Man

The development of strains of insects which are resistant to the usual pesticides may make it necessary to change over to the use of more dangerous substances, for example, in the control of malaria. This is one reason why it is important that the study of the toxicity of modern pesticides and of the precautions necessary in handling them should be actively pursued. A study group set up by the World Health Organization under the chairmanship of Dr. J. M. Barnes (Serum Research Institute, Carshalton, Surrey) has just summarized its findings (World Health Organization: Technical Report Series 1956, No. 114; pp. 51. H.M.S.O; 3*s*. 6*d*.). The report contains useful information on the pesticides containing chlorine and phosphorus and on their toxicity to man and the higher animals, and makes suggestions for safeguards in their use, both indoors and outdoors. Further lines of investigation are suggested. Blood cholinesterase estimation is the most reliable test of harmful exposure to the organophosphorus insecticides, such as parathion. An appendix gives the names of the institutions and their individual workers in the different countries where problems of insecticide toxicity towards vertebrates are being studied. Information is included on the compounds being investigated and the general types of work being done in the different centres.

Amino-acid Metabolism in Detached Leaves

C. D. Nelson and G. Krotkov (*Canad. J. Bot.*, 34, 4, 423; 1956) have investigated the metabolism of carbon-14 amino-acids and amides in detached leaves of the broad bean. Leaves were placed with their petioles in 0·01 *M* ammonium nitrate and allowed to carry on photosynthesis in carbon-14 dioxide for various periods from 12 to 125 min. The radioactivities of the various amino-acids were degraded by decarboxylation with ninhydrin. From the specific activity data it was concluded that the amino-acid closest to the site of carbon dioxide fixation in photosynthesis was alanine, followed by aspartic and glutamic acids, with the amides farthest removed. From the intramolecular distribution of label it was concluded that asparagine and glutamine were formed from their corresponding amino-acids. The labelling in aspartic and glutamic acids was not consistent with the view that these two amino-acids are formed from their corresponding α-keto acids produced by operation of the conventional tricarboxylic acid cycle. A C_3 plus C_2 condensation is postulated for the formation of aspartic acid. A shift in the double bond in the aconitase reaction of the tricarboxylic acid cycle would account for the observed labelling in glutamic acid. When acetate-1-carbon-14 was fed to detached broad bean leaves in the light or dark, the distribution of label in glutamic acid supported the suggestion that there is such a shift in the double bond in the aconitase reaction. Sodium arsenite, infiltrated into tobacco leaves, inhibited the biosynthesis of asparagine but not that of glutamine.

Proceedings of the Fifth Colloquium Ampère

The texts of the twenty-four contributions to the Fifth Colloquium Ampère, held in Geneva during March 21–23, are printed in a special number of Vol. 9 of the *Archives des Sciences*. Nine different countries are represented. Most of the contributions are brief, being only one or two pages in length, and the main topics of discussion are the properties of dielectrics at high frequencies, ferrites, and paramagnetic and nuclear resonance. Review articles are contributed by C. J. Gorter (Kamerlingh Onnes Laboratory, Leyden) on investigations on magnetic resonances during the past twenty years in the Netherlands; L. Guilotto (University of Pavia) on recent work on the time of nuclear relaxation performed at Pavia; A. Lösche (Physikalische Institut, Leipzig) on work on paramagnetic nuclear resonance at Leipzig; P. Grivet (University of Paris) on the development of nuclear resonance in France and on recent progress in experimental methods in the United States; and C. H. Townes (École Normale Supérieure, Paris) on recent developments regarding the measurement of time. The contributions are all in French, and no abstracts are provided.

Functions of the Natural History Museum

Sir Gavin de Beer, director of the British Museum (Natural History), has served a useful purpose by preparing some observations on the functions of natural history museums in general and of the Natural History Museum in particular. It was appropriate that it should appear during "Museums Week" (October 7–13), which was sponsored by the International Council of Museums. Sir Gavin describes the purpose and object of natural history museums and then details their educational function. Stress is laid on the importance of scientific research in natural history museums and the claim is justly made that they are indispensable instruments of modern civilization and human welfare. Apparently this exceedingly useful paper is not a publication in the usual sense of the term, but no doubt copies can be obtained from the British Museum (Natural History) by those interested.

Textile Institute Award for Technical Teachers

The Textile Institute has decided to make a special award of a medal and £20, which, by arrangement with the City and Guilds of London Institute, is offered in that organization's Technical Teachers' Certificate examination to the most successful candidate who is a part-time teacher of textiles. The first recipient is Mr. Robert Noel Ward, of Liverpool, a research chemist with British Enka, Ltd., and part-time lecturer in the manufacture of rayon and

plastics at Mount Street Institute of Further Education, Liverpool.

University of Glasgow

THE following appointments have been made in the University of Glasgow. To the newly created Simson chair of mathematics: Ian M. Sneddon (see *Nature*, 177, 1109; 1956). To senior lectureships: D. R. Bowes (geology) and W. R. Rees (agricultural chemistry, in succession to F. E. Moon). To lectureships: P. V. March and Helmut Mykura (experimental physics), R. H. Pritchard (genetics), D. R. Powell and D. S. Weedon (geology) and J. S. Gillespie (physiology). To Imperial Chemical Industries Fellowships: R. N. Thomson (biochemistry), A. I. Scott and G. A. Sim (chemistry), and R. E. Azuma (physics). To a Nuffield Fellowship in chemistry: C. R. Narayanan. To a Fellowship in natural philosophy: R. V. Hesketh.

Prof. D. H. R. Barton has been granted leave of absence to visit the United States during April 1957, to receive the Fritzsche Medal of the American Chemical Society. For the present session, 412 new students (290 men and 122 women) have been admitted to the science departments, compared with 343 in 1955. In the University as a whole, the total number of matriculated students has increased by about 200 to 5,910.

Oversea Service Division: Colonial Office

THE following appointments have recently been made in the Oversea Service Division, Colonial Office: P. Adams (principal agricultural officer, Sierra Leone), assistant director of agriculture, Western Nigeria; D. A. Donald (senior agricultural officer, British Solomon Islands Protectorate), principal agricultural officer, Northern Nigeria; J. W. D. Goodban (director of agriculture, British Honduras), director of agriculture, Sierra Leone; G. B. Gregory (agricultural officer, Fiji), senior agricultural officer, Fiji; K. Landskrower (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; G. E. O. Okiy (agricultural officer, Eastern Nigeria), principal, School of Agriculture, Eastern Nigeria; W. V. Rose (deputy director of agriculture, Barbados), assistant director of agriculture, Western Nigeria; M. J. Smith (agricultural officer, Federation of Malaya), agricultural officer, North Borneo; E. C. Clarke (assistant conservator of forests, British Guiana), assistant conservator of forests (class 2), Cyprus; T. W. Hussey (senior assistant conservator of forests, Federation of Nigeria), conservator of forests, Southern Cameroons, Federation of Nigeria; P. B. H. Bailey, D. Bleackley and P. H. A. Martin Kaye (geologists, Geological Survey Department, British Guiana), senior geologists, Geological Survey Department, British Guiana; C. G. Dixon (senior geologist, Geological Survey Department, British Guiana), deputy director of geological surveys, Geological Survey Department, British Guiana; J. F. Archibald (senior scientific officer, Uganda), principal scientific officer, Uganda; J. T. Davey (entomologist, Department of Agriculture, Federation of Nigeria), senior scientific officer for posting to the Organisation Internationale contre le Crequet Megratem, Africa; A. L. Wharton (scientific officer, West African Cocoa Research Institute), senior scientific officer, West African Cocoa Research Institute; W. Wilkinson (scientific officer, Commonwealth Institute of Entomology), scientific officer, West African Termite Research Unit; J. F. Hart (provincial veterinary officer, Kenya), assistant director (field services), Veterinary Department, Kenya; R. W. E. Lewis (provincial veterinary officer, Kenya), assistant director (field services), Veterinary Department, Kenya.

Announcements

AT the annual general meeting of the Photoelectric Spectrometry Group the following officers were elected: *Chairman*, Dr. E. M. F. Roe (Chester Beatty Research Institute); *Vice-Chairman*, Mr. J. R. Stansfield (Hilger and Watts). Mr. R. A. Ford (British Nylon Spinners, Ltd.) and Mr. A. W. S. Tarrant (National Physical Laboratory) were elected to the two vacancies on the committee of the Group.

THE Fifth International Low-Temperature Conference on Physics and Chemistry will be held at the University of Wisconsin, Madison, Wisconsin, during August 25–31. Further details will be issued in due course.

AN International Congress on prestressed concrete will be held in Berlin during May 5–10, 1958. Contributions, which should not exceed 4,000 words, must be in one of the four languages, English, French, German or Spanish, and must contain a brief summary in all four languages. Six copies are required and should be received by the general secretary of the Fédération Internationale de la Précontrainte, Mr. P. Gooding, c/o Cement and Concrete Association, Terminal House, 52 Grosvenor Gardens, London, S.W.1, not later than August 1, 1957.

AN International Symposium on "Purity Control by Thermal Analysis" will be held in Amsterdam during April 24–26, 1957, under the auspices of the International Union of Pure and Applied Chemistry and the Commission on Physicochemical Data and Standards. Papers covering all aspects of the subject will be presented by recognized specialists from several European countries and from the United States. Those wishing to attend should apply to the secretary, Dr. W. M. Smit, Centraal Instituut voor physische-chemische Constanten, Biltstraat 172, Utrecht, Holland, for a form of application for membership. Those who register before December 31, 1956, will receive a set of preprints of the papers.

THE Worshipful Company of Glass Sellers of London is offering up to four scholarships in glass technology, tenable at the University of Sheffield. In suitable circumstances, these qualify for supplementation by the Ministry of Education up to the full value of State Scholarships. Further information can be obtained from the Registrar, University of Sheffield, Sheffield 10.

APPLICATIONS are invited for the Helen Putnam Fellowship for Advanced Research, a postdoctoral resident fellowship for women, with research facilities at Harvard University. The research may be in any field related to genetics or mental health, including psychology, child development and other fields of social science. The stipend will be 3,000 dollars a year, with possibility of renewal. Application forms may be obtained from the Secretary, Graduate School, Radcliffe College, Cambridge 38, Massachusetts, U.S.A. Completed applications should be returned not later than January 15, 1957. Announcement of award will be made on or before February 15, 1957.

MAGNETIC RESONANCE

SYMPOSIUM AT BANGOR

A SYMPOSIUM on "Magnetic Resonance" was held at the University College of North Wales, Bangor, during September 26–27, the meeting being sponsored by the Liverpool and North Wales Branch of the Institute of Physics. A hundred and twenty persons attended, of whom twelve came from overseas. The growing appreciation in Britain of the value of nuclear and electron magnetic resonance as analytical and structural tools was revealed by the presence of many chemists and physicists from industry.

The meeting opened with a lecture by Mr. R. Kamper (Clarendon Laboratory, Oxford), who gave an account of resonance experiments on free atoms, in which resonance is detected by enclosing the atoms in a resonant microwave cavity, and measuring the absorption of power as a function of the applied magnetic field. In this way the structure of the magnetic energy-levels is explored, yielding the same kind of information as that provided by atomic beam resonance experiments, but without the attendant difficulties of detection. He went on to describe some current work of Dr. Bleaney's group at Oxford on two isotopes of iodine, free atoms of which are obtained by photo-dissociation of the molecular gas within the cavity itself. This method should be applicable to a large number of atoms and free radicals.

Dr. J. G. Powles (Queen Mary College, London) explained with the aid of a film the formation of spin echoes in nuclear magnetic resonance. The nuclear magnetic moments in a specimen which is usually liquid are first aligned by a steady magnetic field. A pulse of radio-frequency power is then applied which tips the aligned moments through an angle so that they now precess freely about the direction of the steady field with their Larmor frequencies. Since the steady field is never quite uniform, the Larmor frequency is different for different parts of the specimen; the individual moments, therefore, soon get out of phase with each other. At a time τ, a second radio-frequency pulse is applied which turns the nuclear moments round; they now pick up their phase differences at the same rate that previously they had lost them, and come into phase coherence again at a time 2τ. In this temporary condition of recovered phase coherence, the nuclear moments induce a signal in a coil wound around the specimen; this signal is the spin echo. By studying the size of these echoes and of other echoes formed by additional pulses, the two relaxation times T_1 and T_2 can be measured. If a nucleus diffuses from one part of the liquid specimen to another part where the steady field is different, its Larmor frequency changes, and it no longer recovers its original phase at time 2τ and is unable to contribute to the echo. A study of the reduction of echo amplitude due to this cause gives information about the rate of diffusion of molecules in liquids. The latent phase 'memory' in the specimen between the initial pulse and the echo can be used as an information storage device for digital computers.

Mr. G. S. Waters (Signals Research and Development Establishment, Christchurch) explained how the free precession of nuclear moments in a steady magnetic field provides a method for accurately measuring the Earth's field. The protons in a vessel of water are aligned in a field of about two hundred gauss produced by passing current through a coil wound around the vessel. When this field is suddenly switched off, the protons precess in the very uniform field of the earth and induce a signal at their precessional frequency (roughly two kilocycles) in the coil wound on the vessel. By accurately measuring this frequency, the Earth's field-strength can be measured absolutely to about one part in 40,000; relative values at different times of day or in different places can be obtained with even higher accuracy. Mr. Waters and his colleagues demonstrated to the conference a nuclear free precession magnetometer which they had built.

Prof. E. R. Andrew (University College of North Wales, Bangor) reviewed current work in physics at Bangor. He reported measurements of the quadrupole-split spectrum of sodium nitrate, and the verification of first- and second-order theory. The second moment of the centre line has been measured and is in fair agreement with recent theoretical predictions. The relaxation mechanism in this crystal is being studied and a new method was described for determining whether the mechanism is magnetic or quadrupole in origin. When applied to sodium nitrate, the mechanism is found to be quadrupolar. The results were reported of a calculation of the spectrum expected from triangular groups of protons slightly distorted from equilateral form. It was shown that in certain acid hydrates the oxonium ion must be very nearly equilateral in form, the possible departure consistent with experiment being not more than about ten per cent. The traditional X-ray work on metals and alloys is being maintained in the department. Work was reported on a range of alloys similar to the ferromagnetic Heusler alloys, but with silver or gold replacing copper, and also on binary alloys of manganese with silver and gold; the structure and magnetic susceptibility have been measured over a wide range of temperature. A critical temperature of 190° C. for the order–disorder transformation in $CuAu_3$ has been found by X-ray and resistivity measurements. An increase in resistivity of disordered Cu_3Au near the critical temperature, found by pulse-anneal measurements, is attributed to short-range order. Work on nickel–zinc ferrites has shown that the resistivity obeys the simple exponential dependence on temperature characteristic of semiconductors, with no discontinuity at the ferrimagnetic transformation temperature. On the other hand, the magneto-resistance is closely associated with the ferrimagnetism.

All magnetic resonance work requires a magnetic field, and the provision of a suitable magnet is usually the most difficult problem confronting the experimenter. Dr. R. E. Richards (Physical Chemistry Department, Oxford) summarized the desirable attributes of magnets for electron magnetic resonance and for low- and high-resolution nuclear magnetic resonance. Uniformity of magnetic field to 1 part in 10^6 over a volume of 1 cm.^{3}, coupled with a stability rather better than this, generally suffices for electron work and for low-resolution nuclear work, and can

be provided at modest cost by permanent magnets or electromagnets. On the other hand, high-resolution nuclear magnetic resonance spectroscopy demands a uniformity of one part in 10^7 and stability to better than this. A large carefully engineered electromagnet with first-class electronic regulation will meet the requirements, and indeed such a magnet is marketed in the United States. A large carefully engineered permanent magnet with temperature stabilization is equally satisfactory. In either case the cost is high. Dr. Richards outlined Purcell's method of smoothing out irregularities of field caused by inhomogeneity of the magnet alloy; the pole caps are made of layers of soft iron and diamagnetic material which attenuate the irregularities in much the same manner that electrical fluctuations are reduced by the successive sections of a filter. In the discussion which followed, diverse views were expressed on most aspects of design—pole-cap contour and figuring, shims, pole-cap material, magnetic material, yoke configuration. It seems that much has yet to be learnt before one can confidently assert what are the best and most economical designs of magnets suitable for high-resolution work.

At a business session held during the symposium, a proposal was approved to form a Radiofrequency Spectroscopy Group which would arrange future occasional meetings. For this purpose radiofrequency spectroscopy was deemed to cover work at all frequencies up to about 10^{11} c./s., and therefore includes electron- and nuclear-resonances and also microwave spectroscopy of gases.

E. R. ANDREW

ANNUAL CONFERENCE OF THE PHILOSOPHY OF SCIENCE GROUP

THE first annual conference of the Philosophy of Science Group of the British Society for the History of Science was held during September 21–23 at Ashburne Hall, University of Manchester, under the chairmanship of Dr. G. J. Whitrow, chairman of the Group, and was attended by about fifty members and guests. Mr. R. F. J. Withers acted as conference secretary.

Symposia were held on "Cybernetic Models and Thought Processes", "The Nature and Scope of Scientific Method", "The Status of Irreversible Processes in Physical Theory" and "The Role of Historical Explanations in Science".

In the first symposium, papers were read by Dr. W. Mays and Dr. W. Ross Ashby, and Prof. J. H. Woodger took the chair. Dr. Mays raised the question of the adequacy of cybernetic models for human thinking and learning behaviour. He held that the question, 'Can machines think?' is not simply a semantic but a factual one; and the answer is 'Yes' only if machines and humans reach their conclusions by similar processes. Dr. Ashby was interested in giving a clear account of 'model' as something that is from a relevant point of view similar to that which is modelled, so as to lead to results which can be tested. To be tractable, however, a model must also be an over-simplification. Hence, all models of the brain have been inadequate, but they have thrown light on aspects of it; in particular they have focused attention on the basic question, 'How much information is involved in this process?' Subsequent discussion centred around the concept of model, its nature and role. There seemed to be a general consensus of opinion that, although mental processes have not so far been adequately represented by cybernetic models, some models have proved useful.

A connecting link developed between this discussion and the next one, for in discussing models attention was directed to the role of theories in science. This question figured prominently in the second symposium. For this the chair was taken by Dr. J. O. Wisdom, and the opening paper was given by Dr. G. W. Scott Blair on "Scientific Method as a Specialized Intellectual Activity". He considered that the mental processes involved in scientific activity consist of observing, selecting, relating and deducing. He pointed out that there are parallel processes involved in tests of general intelligence, and therefore claimed that the specialized mental activity that goes to make science is not unique but is shared by other intellectual activities. Prof. R. O. Kapp followed with a paper on "What is a Law in Physics?" He laid great stress on what he called the principle of minimum assumption. He showed with examples that this is not merely a method of economy but also provides a means of deriving important results in theoretical science. He considered, for example, that Dirac could not have predicted the positron without (though perhaps not overtly) relying on this principle. Mr. Z. M. T. Tarkowski then spoke on "The Interaction of Experiment and Theory in Science". After giving an account of the general way in which theories are used, he contended that Galileo's experimental results did not bear out his kinematical hypotheses, and inferred that a theory may have the right to be regarded as possibly true even though the evidence is against it.

The third symposium was more specialized. The chairman of the Group took the chair, and Prof. M. S. Bartlett read a paper on "Irreversibility and Statistical Theory", in which he presented a survey of the development up to the present day of the concepts of irreversibility and entropy. He pointed out that the paradoxes of reversibility reappear in statistical mechanics. He suggested that statistical reversibility for very small systems is consistent with their possible lack of any intrinsic time-direction. Mr. L. L. Whyte then spoke on "The Mathematics of One-way Processes", the traditional problem being to account for one-way processes moving towards equilibrium on the assumption that elementary atomic processes are reversible. This he regarded as over-simplified, since owing to the effect of magnetic fields no single electronic process is reversible unless all electronic motions are simultaneously reversed. A more fertile problem may be to determine conditions under which certain constant parameters can provide satisfactory approximations in a theory of one-way processes. In the discussion which followed, a short note was presented by the chairman from Prof. K. R. Popper, who argued that no logically satisfactory version of the second law of thermodynamics exists. He suggested a possible reformulation of the law, but directed attention to the serious logical difficulties in the way of any reformulation.

In the final symposium, Mr. R. P. Gould discussed "The Place of Historical Propositions in Biology". He contrasted explanation in science with explanation in history. After describing similarities and differences between the kinds of statement found in science

and history, he aimed at showing how scientific explanatory hypotheses can be used to explain what has happened in the past. In this way it is possible to give scientific explanations about the evolution of extinct organisms; but he considered that, because of inadequate information, statements about the physiology, biochemistry, and so on of extinct organisms must be treated with caution. Mr. J. W. N. Watkins then spoke on "Historical Explanations in the Social Sciences". He advocated 'methodological individualism' as an essential principle for social science. According to this principle, there are no 'holistic' sociological laws that are irreducible to laws about the situations, dispositions, aims, etc., of individual persons. He claimed that the principle could account for organic-like social behaviour, and he described ways in which explanations of social regularities and of unique historical events could be framed in accordance with it. Mr. R. F. J. Withers, who took the chair, pointed out that there is a difference between scientific explanation and the use of techniques; and the general discussion showed that several biologists were loath to look on scientific explanation, when applied to evolution, as historical.

Animated discussions took place in each symposium. The conference was generally felt to have justified the efforts of those responsible for organizing it, particularly as it became evident that greater clarity concerning problems of scientific method and explanation could facilitate further progress in science itself. Plans for future conferences outside London were discussed. It was provisionally arranged that the next will be held at a week-end towards the end of September 1957. An announcement will be made in *The British Journal for the Philosophy of Science* early in 1957.

NUFFIELD FOUNDATION

REPORT FOR 1955–56

THE eleventh report of the Nuffield Foundation, covering 1955–56*, specially emphasizes in its introduction the general ideas on which the Foundation attempts to plan its operations. Concerned to finance projects that may yield dividends not in terms of cash but of public good, the Foundation inquires first into the credit-worthiness of the applicant; second, into the originality of his idea; and third, into the soundness of his project. It is least interested in investments which will produce a modest return, and with depressing frequency it may find that the number of good projects exceeds the number of good men to execute them. Moreover, the Foundation must also go out and seek profitable investment. It is not its job to sustain work which everybody agrees ought to be done; it dare not even continue to support indefinitely its own successful schemes, lest it quickly consume resources out of which new ones can be attempted. In this seeking of new and rewarding ventures, the Foundation is greatly helped by its visitors and advisers, including those from the universities, learned societies, research institutes, philanthropic societies, hospitals and government departments, who bring ideas as well as information. The Foundation must be free to make rapid changes of emphasis in its interests, and it is important that the size of a grant should be nicely judged so as not to stunt nor stifle. Its funds, too, should not be scattered over a wide range of unrelated schemes, and its policy should be neither vague nor rigid, its programme neither shapeless nor fixed.

Grants for biological research in the United Kingdom include a further grant of £2,410 for one year to The Queen's University of Belfast for studies on population genetics in Northern Ireland under Prof. A. C. Stevenson which are gradually building up a detailed knowledge of the frequency and distribution of specific genes. A grant of £4,800 over five years has been offered to the Plant Breeding Institute, Cambridge, for the salary of a plant cytologist with some knowledge of biochemistry to work mainly at the Institute under the joint supervision of its director, Dr. G. D. H. Bell, and of Prof. J. S. Mitchell, of the Department of Radiotherapeutics, on the modification by chemical means of radiation effects in plants such as broad beans and barley. A further grant of £4,500 over 1956–59 has been made to the University of Glasgow for the work under Prof. G. Pontecorvo on the genetics of micro-organisms, which it is hoped may lead to the discovery of a chemical basis for the genetical phenomena of 'crossing over'. A further grant of £14,200, payable in declining amounts over five years to the Royal Anthropological Institute, London, is to enable the Nuffield Blood-Group Centre to continue its work until other financial provision can be made, and the grant to the Lister Institute of Preventive Medicine, London, for the work on the chemical analysis of immunity-provoking agents has been renewed at the rate of £3,000 a year for a further five years.

A grant of £4,850 over three years has been made to the University of Oxford in support of Dr. A. E. M. Weddell's study of free nerve terminals in the cornea of untreated leprotic patients, and an additional grant of £12,000 over three years has been made to University College, London, for work on the problems of analogues for the cerebral mechanisms involved in the learning processes of the octopus; £6,300 over three years to the Institute of Psychiatry, University of London, is for Prof. H. McIlwain's work on the control of metabolism in normal mammalian cerebral tissues. Another grant to University College, London, of £4,246 over three years, is for the construction of a micromanipulator which will transmit the sense of touch. The Foundation has provided £2,500 for the Department of Agricultural Botany, University College of Wales, Aberystwyth, for equipment to control light, temperature and humidity in research on the influence of environment on the mechanics of growth and inheritance. A final grant of £2,700 over three years has been made to the University of Cambridge for Dr. J. W. Millen's and Dr. D. H. M. Woollam's work on hydrocephalus in rabbits due to deficiency of vitamin A, and a grant of £2,530 has been offered for work on the flight muscles of the bumble bee and on the electric discharges from fishes. The Foundation has also offered £1,500 a year for a further two years to the University of Durham in support of Prof. J. Baddiley's work on the structure and synthesis of co-enzyme *A*.

Other scientific grants include £1,750 a year for two years for the establishment of a lectureship in polar studies at the University of Durham; £8,000 over four years to the Imperial College of Science and Technology, London, for Prof. R. M. Barrer's work on the synthesis and properties of natural and synthetic minerals, especially aluminosilicates; £600 for special

* The Nuffield Foundation. Report for the Year ended 31 March, 1956. (Eleventh Report.) Pp. 160. (London: Nuffield Foundation, 1956.)

equipment and £1,200 over three years for a research assistant for work in the Department of Physics, University of Cambridge, on the use of X-ray diffraction methods to measure electron density distribution in chemical bonds; and a further £880 to the University of Cambridge for Dr. D. J. Price's work on the history of scientific instruments. The Division for Architectural Studies of the Nuffield Foundation has now taken up a study of tropical architecture in relation to human comfort and has been invited to design halls of residence and a dining hall for students of the Imperial College of Tropical Agriculture, Trinidad. Its survey of requirements in laboratories in England and Scotland was to be completed in mid-September, 1956, and its study of the environment to be provided for children in hospital has led to the delineation of a series of problems needing special study, while at Musgrove Park Hospital, Belfast, the Division's experimental work has brought down the cost of efficient and attractive accommodation to about £1,000 a bed.

Apart from chronic rheumatic diseases, to which the Foundation devotes the income of the Oliver Bird Fund and a like amount from its other resources, the Foundation does not normally assist the study or treatment of specific diseases. In this field the Foundation's financial help during the present period goes mainly to the Rheumatism Research Centre in the University of Manchester and to the Rheumatic Unit at the Northern General Hospital, Edinburgh. Besides additional grants of £70,000 over eight years and £65,750 over five years a new grant of £10,000 over three years was made during the year to the Department of Chemical Pathology, St. Mary's Hospital Medical School, London, for further fundamental work under Dr. A. Neuberger on the tissues of the body which are involved or damaged in the rheumatic diseases. Other grants during the year for medical research include £3,000 to the Royal National Throat, Nose and Ear Hospital, London, in support of a pilot course of one year to discover the best kind of training and the best form of preliminary education of a new type of worker who will be primarily concerned with training the pre-school deaf child; £2,000 to the University of Oxford to re-equip Dr. Peter Daniel's general work, with £1,000 for equipment and £3,840 over two years for a special study, on the after-effects of tuberculous meningitis; £20,000 over five years to the University of London for the maintenance of the biomechanical unit established by the Institute of Orthopaedics and King's College to apply the methods of mechanics to the study of forces and actions in the living body; £10,000 to finance the production of a further six Melrose heart–lung machines; and £3,000 a year for two years to the Department of Surgery, University of Bristol, for work on congenital heart disease, involving the establishment of a fully documented register of cases and experimental work to correct congenital abnormalities of the heart while circulation is maintained by a pump.

In social research and experiment the largest grant during the year was £200,000 over six years to Nuffield College, Oxford, to complete the building, which is expected to be substantially finished in three years time, when the College will become residential. The group which the Foundation sent to North America in June and July 1955, to report on the agricultural advisory services in the United States, issued its report last June. The team noted that, in proportion to the value of agricultural output, the United States spends half as much again as Britain on advisory services; it was impressed by the American system of co-ordinating agricultural teaching, research and advice by basing all three on the State land-grant college; by the co-operative arrangement whereby the advisory service is jointly financed by Federal, State and County governments; and by the system of planning the year's programme in consultation with the farmers of the community, and of measuring results against defined goals. The report suggested that, if it were impracticable for university departments of agriculture in England and Wales to take responsibility for the advisory service, a strong working liaison should be established between the advisory service and university departments, agricultural colleges, and farm institutes.

Two further grants have been made to the Department of Social Anthropology of the University of Edinburgh: one of £1,500 over two years for a study of racial problems in Brixton, which appears to be an unofficial reception area for working-class immigrants from the West Indies; and £750 for a general survey of recent research into racial problems in Britain. A grant of £2,500 over two years was for Prof. C. A. Mace's investigation at Birkbeck College, London, into the aspirations of school-leavers, and £9,000 over three years has been offered to Political and Economic Planning for a study of family needs and the social services. A further grant of £5,000 was made to the Administrative Staff College, Henley, for a study of the machinery through which the relations between industry and government are conducted and an investigation into the characteristic pattern of enterprises in Britain and ways in which general policy is made, especially under the impact of change; and £1,700 a year for three years has been offered to the Department of Economics and Commerce of the University of Leeds to enable its unit for industrial management to benefit from a visiting professor or comparable expert from the United States or Canada.

A grant of £1,500 a year for two years to the University College of Swansea is for sustaining its social welfare service for overseas students to the end of the university quinquennium.

Grants for education include £3,000 to the Royal Institution, London, for its work in overcoming the shortage of science teachers; £10,000 to enable a Nuffield collection of children's books to be added to the library of children's books of the National Library for the Blind, and up to £50,000 to the Police College Trust to build and equip a dining-hall at its new premises at Bramshill House, near Hartley Witney. Grants amounting to £60,000 over three years have been offered to voluntary bodies providing chiropody for the old at reduced rates; the grant in support of Dr. D. A. Hill's gerontological research fellowship and unit, which has extended its studies to include collagen, has been renewed at the rate of £6,000 a year; besides a further grant of £2,610 over three years for Mr. F. Le Gros Clark's studies on the employment of older workers, a grant of £2,000 over two years has been made to the Slough Industrial Health Service for a study, under Mr. Le Gros Clark's supervision, to assess the possibilities of employment open to the older worker no longer able to carry on with his normal work.

Grants for the British Commonwealth overseas include £2,080 over two years to the University of Melbourne for research on the enzymes of the endocrine glands, and £1,600 for two years for Dr. V. D. Hopper's study there of heavy primary cosmic-ray particles with nuclear emulsions; £1,600 for one year

for Dr. S. S. Angyal's study, with carbon-14 labelled inositol, of biochemical applications which would illuminate the role of inositol in living organisms; £18,000 towards the capital cost of a primary health unit being built by the Christian Medical College and Hospital at Vellore, affiliated to the University of Madras, to provide comprehensive care for a rural community of thirty thousand people; £3,150 during 1955–57 to the Bernard Price Institute of Geophysical Research, University of the Witwatersrand, for its study of the age of the granite of the Bushveld Igneous Complex; £7,000 for wider family studies in Jamaica; and £3,000 for capital expenditure and £2,500 for the maintenance costs over three years of an experimental farm attached to the Gayaza Girls' High School, Uganda, where progressive agriculture will be practised and taught in conjunction with dietetics.

Travel grants include £1,500 to enable Prof. E. B. Verney, of the Department of Pharmacology, University of Cambridge, to spend four months in Melbourne in research on surgical technique and another to bring to Britain for a year's postgraduate experience, Dr. Ijaz-ul-Haque, of the De Montmorency College of Dentistry, Lahore. In Britain one award was made in medicine, six in dentistry and two in biology; three fellowships were given to Home Civil servants. The scheme of travelling scholarships and bursaries for United Kingdom farmers has now come to an end, but eight scholarships were awarded during the year and four bursaries. The Foundation is now offering for a limited period each year one or two travelling fellowships to enable selected builders, building scientists or architects to study abroad at a recognized institute or with an organization of international standing. Twenty awards were made in 1955 under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme, and the Foundation will continue its contribution of £3,000 for a further three years. On the recommendation of the Foundation's advisory committees in the Commonwealth, eleven fellowships were given in medicine, eight in natural science, four in social science and humanities, and one in engineering.

THE FLORAL MERISTEM AS A REACTION SYSTEM*

By Prof. C. W. WARDLAW

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FLORAL ontogenesis has long been a preoccupation of morphologists. In trying to understand the physiological mechanism that underlies and determines the orderly formation of the several kinds of floral organs, it is essential to consider the organization and functional activities of the apex of the antecedent leafy shoot. The most general characteristic of the growing shoot apical meristem is that it gives rise to a succession of regularly spaced leaf primordia, sometimes of very variable form and structure, these having their inception in loci of special metabolism, or growth centres. The latter typically originate in the subdistal region of the meristem. The initial state of this region, which consists of equivalent embryonic cells, may be such that the reacting metabolic substances are homogeneously distributed in it. A contemporary chemical theory of morphogenesis envisages the possibility that a reaction system of this kind, in obedience to the laws of physical chemistry and mathematics, and on being activated, can give rise to a patternized distribution of metabolites, for example, of growth centres, this constituting the chemical basis for the ensuing morphogenetic developments. This general property of the apex is maintained throughout the floral development, however much it may be modified in other ways. It is also known that the positions of new primordia are affected by those already present around the meristem.

At a certain stage in the development of a flowering plant, and often in direct relation to exposure to some characteristic photoperiod, it is held that new metabolic substances enter the apical reaction system. This substance (or substances) has not yet been specified or isolated, but it may be hormonal or enzymic in nature or action. Important, usually irreversible, changes ensue. The allometric growth pattern of the apex is radically changed; in particular, the elongation of the axis is greatly curtailed, so that the growth centres, and the lateral organs to which they give rise, are now formed in closely associated groups, either whorls or condensed helices, on an abbreviated floral axis. A characteristic feature of floral ontogenesis is that the apical reaction system passes through a sequence of well-defined phases. Physiological correlations are almost certainly involved in the changing phases of floral development, just as they are in the antecedent vegetative developments. As a result of the initial change in the state of the reaction system, the action of specific genes, hitherto inert, is induced. The changes thereby effected in the system lead to further specific genic action; and so on, until flower formation terminates with the utilization of all of the residual distal meristem. It is probably to the action of particular genes (or groups of genes), as components of the reaction system, that the clear delimitation of the several organogenic phases, that is, the formation of calyx, corolla, androecium and gynoecium, should be attributed. These several conceptions appear to afford a basis for the conspicuous features of floral ontogenesis, namely: (1) that the several floral organs are homologous with leaves; (2) that they are formed in a characteristic pattern on the meristem; (3) that the successive groups of growth centres, formed during the course of floral ontogenesis, have each distinctive physiological properties and accordingly give rise to organs which differ in form and structure from each other.

Among the advantages of the theory as outlined above are: (*a*) that it attempts to bring the morphological facts of floral ontogenesis into direct relation with physiology, genetics and the dynamic geometry of the embryonic apical region; (*b*) that many of the former highly controversial issues, for example, of homologous and non-homologous floral organs, of organs *sui generis*, of morphological 'transitions', etc., disappear as consideration of the relevant phenomena is transferred from the morphological to the physiological plane; and (*c*) that it suggests important opportunities for new observational and experimental work on floral ontogenesis, both in its more general as well as its more specific aspects. Recent investigations of the relation between metabolic factors and heteroblastic leaf development support the theory now advanced.

* Abstract of a paper read before the Royal Society of Edinburgh on November 5.

THE BALD EAGLE OF NORTH AMERICA

ATTACHED to the bald eagle is a degree of popular interest far beyond that normally associated with other birds of prey. Early in the history of the United States the bald eagle, of all the varied forms of wildlife in North America, was selected as the national emblem. By act of Congress, on June 20, 1782, a design for the national coat-of-arms displaying the bald eagle was adopted.

In a paper published by the Fish and Wildlife Service of the United States Department of the Interior*, Ralph H. Imler and E. R. Kalmbach have reviewed the economic status of the bird. Information has been assembled from reliable sources, from the examination of a series of stomachs and crops of bald eagles, and food remains at nests, to permit a current appraisal of the economics of the bird both within the borders of the United States and in the Territory of Alaska. Study of the economics of the bald eagle was prompted largely by the need for information to appraise the merits of bounty and other legislation affecting the eagle in the Territory of Alaska, where it long has been the subject of controversy. Although the bald eagle was noticeably reduced in south-eastern Alaska during the years of bounty payments after 1917, there are indications that the bird is now regaining its numbers and may again assume its former abundance in favoured areas.

* Fish and Wildlife Service of the United States Department of the Interior. Circular 30: The Bald Eagle and its Economic Status. By Ralph H. Imler and E. R. Kalmbach. Pp. ii+295–330. (Washington, D.C.: Government Printing Office, 1955.) 30 cents.

As a basis for laboratory food studies, 435 stomachs of Alaskan bald eagles were collected and examined. In addition, data are available from thirty-one stomachs collected in the United States, and six stomachs collected in Canada. Nearly two-thirds of the food of Alaskan eagles was composed of fish, and of this about one-sixth (16·9 per cent) was salmon. Imler and Kalmbach believe that most of the salmon was carrion when found by the birds. An appreciable, but uncertain, portion of the other fish consumed was known to be dead when located by the eagles. Less than one-fifth (18·8 per cent) of the Alaskan eagles' food was derived from birds, the remainder being various marine species plentiful in the north Pacific.

Stomach examination has substantiated to a limited extent the reported predation of the bald eagle on deer. There is no evidence that the bald eagle exerts an appreciable effect on the population of small mammals unless it should be during winter when numbers of these birds may congregate in areas where jackrabbits are abundant.

Only in Alaska is the bald eagle abundant enough to constitute a significant hazard to domestic livestock, and even there its most important relation is with the semi-domesticated blue fox. During recent years, this problem has been materially alleviated, the more progressive raisers confining their animals under screens. Within the United States, the bald eagle has occasionally preyed on domestic poultry, but here again the small number it takes makes the total effect insignificant.

ORIGIN OF THE CHARACTERISTIC ENERGY LOSSES OF ELECTRONS IN SOLIDS

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THE characteristic energy losses of electrons passing through thin foils[1] have been interpreted in terms of collective oscillations by Bohm and Pines[2] and in terms of high-lying 'quasi-stationary' excited states by Hayasi[3]. It is the purpose of the present article to outline an alternative explanation in terms of individual atomic ionization and excitation processes according to the Bohr–Bethe theory for the stopping of charged particles.

On this interpretation, the principal energy loss occurring for all substances between approximately 12 and 22 eV. represents the ionization of the bound shell next to the valence-level, for which the binding energies range from about 10 to 20 eV. throughout the atomic table. The weaker loss lines below ~ 12 eV. are considered to represent excitations and ionizations of the valence electrons. As indicated schematically in Fig. 1, the ionization processes give rise to a characteristically asymmetrical energy loss peak of the same form as the known energy distribution curves of the secondary electrons[4]. The form of the secondary electron energy distribution curve and the location of the peak at about 2 eV. above the zero energy vacuum reference-level is predicted by the theory of ionization[5] and has been observed to be essentially the same for gases[6], metals[4] and insulators[4]. Since the half-width of these curves is only about 2–4 eV., the narrow peak is equivalent to a rather well-defined final state required to explain

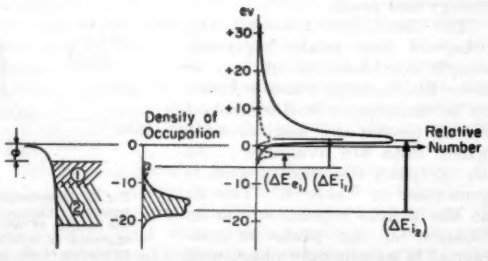

Fig. 1. Schematic diagram illustrating the fundamental energy-loss processes

the sharpness of the observed loss lines in some elements such as aluminium.

The dominance of the processes involving the bound shell next to the valence-level follows directly from the expression for the number of inelastic collision with a given shell per unit path-length according to the Bohr–Bethe theory. In the approximation used by Bohr[7], this quantity is given for the (n,l)-shell by the expression

$$s_{n,l} = \frac{2\pi e^4 N}{V}\left[\frac{Z_{n,l}}{E_{n,l}}\ln\left(\frac{2V}{E_{n,l}}\right)\right] \qquad (1)$$

where V is the volt-energy of the incident electron of charge e, N is the number of atoms per unit volume, $Z_{n,l}$ the number of electrons in the (n,l)-shell and $E_{n,l}$ is the excitation energy, roughly equal to its binding energy $I_{n,l}$.

Examination of equation 1 shows that for $V \gg E_{n,l}$, $s_{n,l}$ varies almost directly with $Z_{n,l}$ and inversely with $E_{n,l}$. It follows that especially in the heavier elements, the number of collision processes with the bound outer shells will dominate. Thus, for the case of copper, taking $E_{n,l}$ as approximately equal to $I_{n,l} + \overline{E}_{se}$, where $\overline{E}_{se}$ is the average energy carried away by a secondary (~ 6 eV.), one gets $E_{3s} \simeq 12$ eV. and $E_{3d} \simeq 23$ eV., making $s_{3d}/s_{4s} \simeq 5$. The same dominance of the interaction with bound electrons has recently been suggested as explaining the associated phenomenon of secondary electron emission[8].

Since transitions from the filled levels terminate predominantly in the continuum, the strongest energy-loss line corresponds to ionization or secondary electron formation from an outer bound shell. The most probable value of the associated energy loss (ΔE_{i2}) would be expected to be a few eV. greater than the binding energy of the peak density point in the filled shell as determined by X-ray results. For the valence shell, excitation has a probability comparable to ionization, giving rise to an energy loss (ΔE_{e1}) of the order of the work-function φ. The ionization of the valence shell itself must lead to a loss (ΔE_{i1}) greater than φ by ~ 2–4 eV.

It appears that all the observed losses of higher energies can be explained as simple multiples or combinations of the dominant three fundamental processes (ΔE_{e1}), (ΔE_{i1}) and (ΔE_{i2}). Since the successive collisions are statistically independent, the relative weight of the various possible combinations is determined by simple probability considerations, which will govern the intensities of the higher energy-loss peaks.

The condition that all the observed loss peaks represent simple combinations of two or three fundamental losses is found to be remarkably well confirmed for all metals and insulators for which data are available[1]. As an example, the case of gold is presented in Table 1. The fit to the simple scheme so far as location of the peaks is concerned is surprisingly close, well within the experimental uncertainty of ± 2 eV. Furthermore, it should be noted that the particular combinations actually observed experimentally follow the pattern expected from probability considerations. Thus, there are never more than two events of small cross-section (ΔE_{e1} and ΔE_{i1}) required to account for any peak and never more than three events of any type making up a single loss line, with the exception of the event with highest expected cross-section (ΔE_{i2}), for which there are as many as four repetitions.

Table 1

Observed energy losses	Present interpretation		Plasma theory interpretation
eV.	Type No.	eV.	eV.
3·0[a]	A^1	3·0	—
5·2[a], 5·8[a], 6·5[d]	A	5·2	—
8·6[a], 7·3[a]	$A + A^1$	8·2	$\hbar\nu_{pl}$ = 9·0
10·1[a]	$2A$	10·4	—
16·1[a], 14·4[c], 15[b]	B	15·7	—
17·5[d]	$B + A^1$	18·7	$2\hbar\nu_{pl}$ = 18·0
20·0[a]	$B + A$	20·9	—
23·9[a], 24·0[a], 25[d]	$B + A + A^1$	23·9	—
25·9[a], 27·5[c]	$B + 2A$	26·1	$3\hbar\nu_{pl}$ = 27·0
30·0[b], 32·0[c], 32·2[a]	$2B$	31·4	—
34[d], 35·2[a]	$2B + A$	36·6	$4\hbar\nu_{pl}$ = 36·0
45[b], 49[d], 47·5[a]	$3B$	47·1	$5\hbar\nu_{pl}$ = 45·0
60[b]	$4B$	62·8	$7\hbar\nu_{pl}$ = 63·0

Note: $A^1 \equiv (\Delta E_{e1})$, $A \equiv (\Delta E_{i1})$, $B \equiv (\Delta E_{i2})$.

(a) Rudberg, E., *Proc. Roy. Soc.*, A, **127**, 111 (1930); *Phys. Rev.*, **50**, 138 (1936).

(b) Möllenstedt, G., *Optik*, **9**, 473 (1952).

(c) Marton and Leder, *Phys. Rev.*, **94**, 203 (1954).

(d) Watanabe, H., *J. Phys. Soc. Japan*, **9**, 920 (1954).

(e) Gabor and Jull, *Nature*, **175**, 718 (1955).

The present explanation may be tested by calculating the expected form of the loss spectrum for the principal loss (ΔE_{i2}) in the case of aluminium at two different energies. To obtain the relative contribution of each multiple collision, it is necessary to find the expected number of collisions $(s_{n,l})d$ in a thickness d from equation 1, and then to calculate the probability of the occurrence of 0,1,2,3 . . . collisions according to the Poisson distributing law. This has been done for aluminium using $E_{n,l} = I_{n,l} + \overline{E}_{se} = 19$ eV. and $Z_{n,l} = 2$ for the 3*s*-shell, giving $\lambda_{n,l} = (s_{n,l})^{-1} = 140$ A. at 7·6 keV. and 460 A. at 30 keV. The resulting curves are shown in Fig. 2,

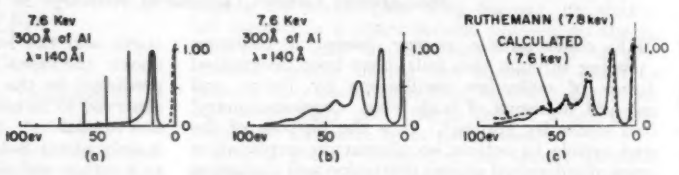

Fig. 2. Comparison of calculated and observed loss spectra in aluminium at two different energies. Curve (*a*) shows the assumed shape of the principal loss, and vertical lines the heights of which represent the expected numbers of single, double, triple, etc., events expected in a 300-A. layer. Curve (*b*) shows the sum of all the losses derived from repetition of the properly weighted principal loss curve of (*a*). Curve (*c*) shows the comparison with observed spectra. Curves a^1, b^1, c^1 are similarly derived for a thinner layer and higher bombarding voltage

calculated for $d = 300$ A. as used by Ruthemann[9] and $d = 70$ A. used by Leder and Marton[1]. The form of the fundamental loss curve (a) was taken from typical secondary electron energy spectra. The shapes of the higher order loss peaks were determined by carrying out a numerical convolution process weighted according to the Poisson distribution shown by the vertical lines in (a) and (a^1). It is seen that the calculated spectra due to the principal loss at 14·7 eV. satisfactorily reproduce the observed number of peaks as well as their relative amplitudes and shapes.

Although this agreement strongly supports the hypothesis that the observed losses represent combinations of only a few types of independent atomic collisions, thus making it unnecessary to postulate a whole series of high-lying 'quasi-stationary states'[2], it does not by itself rule out the explanation involving excitation of plasma oscillations[3]. This is due to the fact that the form of the expression for the mean free path obtained in plasma theory is essentially the same as that of equation 1, and that, for the case of aluminium, a quantum of the plasma oscillation has an energy roughly equal to $E_{n,l}$, while at the same time the number of valence electrons is very nearly equal to $Z_{n,l}$ for the 3s-shell. As a result, plasma theory leads essentially to a similar mean-free-path and amplitude distribution in the loss spectrum for aluminium, although it must be noted that the characteristic asymmetry in the shape of the loss peaks does not seem to be explained by any simple plasma resonance mechanism.

A more definite distinction between the two proposed mechanisms can, however, be made in the case of the heavier elements, where $Z_{n,l}$ for the filled shells is much larger than the number of free conduction electrons. Thus, for the case of copper $(s_{n,l})^{-1} \simeq 80$ A. at 30 keV. according to equation 1, and $\simeq 760$ A. according to the plasma theory, using the usual assumption of one conduction electron per atom. Essentially the same situation holds for all the noble metals, so that according to plasma theory, one would not expect to find the high-order multiple loss-peaks in the case of gold (Table 1) for the energies and layer thicknesses used ($\sim$ 100–200 A.)[4]. Thus, to account for a loss peak at 60 eV. with a fundamental plasma loss $h\nu_{p,l} = 9{\cdot}0$ eV.[5], approximately seven repeated events would have to occur. But this would require a mean-free-path at least ten times smaller than calculated from plasma theory.

Inasmuch as the collision cross-section for the bound outer shells cannot be expected to be affected strongly by changes in the state of aggregation or the bulk properties of the solid, it is also no longer surprising that characteristic losses of essentially similar type have been observed in metals and insulators. For the same reason, a crucial test that can clearly decide between the individual atomic and collective loss mechanisms would be provided by measurements on metal vapours.

In view of the close correlation of the characteristic losses with the fine-structures of X-ray absorption edges and short-wave limits noted by other investigators[4], it appears possible to explain these effects also in terms of the energy loss mechanism outlined above.

A more detailed discussion of this problem will be presented elsewhere. I am indebted to Mr. L. B. Leder and Drs. L. Marton, E. N. Adams, J. W. Coltman and R. L. Longini for helpful discussions of this problem.

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GENETIC STUDIES OF THE RELATIONSHIP OF TUMOUR–HOST CELLS

Detection of an Allelic Difference at a Single Gene Locus in a Small Fraction of a Large Tumour-Cell Population

A SERIES of experiments is being carried out in this laboratory with the view of inducing mutations at certain gene loci in tumour cells, either by non-specific means such as X-rays, or in a more specific way by treatment with deoxyribonucleic acid of specific origin. The basic material of this study consists of tumours induced in F_1 hybrid mice, produced by crossing the inbred A-strain with one of the three isogenic sublines *A.SW*, *A.BY* or *A.CA* (kindly provided by Dr. G. D. Snell). These sublines have been developed by Snell[1,2], and they are known to differ from the A-strain by one gene only, having a different allele at the histocompatibility-2 (H-2) locus. This difference makes all three sublines resistant against grafted tissues and tumours of all other sublines and the A-strain itself, in spite of their genetic identity with regard to all or most other loci.

An F_1 hybrid produced by crossing the A-strain with one of the isogenic resistant sublines is theoretically homozygous with respect to all loci except H-2, which presents the heterozygous condition. Tumours arising in such F_1 hybrids should be transplantable to other F_1 hybrids of the same genetic composition, but not to any of the parental sublines, since the latter would be able to produce a homograft reaction against the antigenic products of the foreign H-2 allele derived from the other parental subline and contained in the tumour cells in a single dose.

We have induced a series of sarcomas in such F_1 hybrids by methylcholanthrene. The majority of these tumours was found to behave according to expectation and with great rigidity. There were some exceptional tumours, however, that grew in one or both parental strains from the beginning or after

Table 1

Tumour I				Tumour II				Mixture I + II		Result	
Name	Induced in	Genotype	No. of cells inoculated	Name	Induced in	Genotype	No. of cells inoculated	Inoculated into	Genotype of hosts	Ratio of mice killed by tumour to total number inoculated	Percentage killed by tumour
DSWB	*A* × *ASW* F_1	*H*-2^a*H*-2^s	~ 5 × 10^7	—	—	—	—	*A*	*H*-2^a*H*-2^a	0/30	0
DSWB	*A* × *ASW* F_1	*H*-2^a*H*-2^s	~ 5 × 10^7	—	—	—	—	*A* × *ASW* F_1	*H*-2^a*H*-2^s	30/30	100
—	—	—	—	*S4A*	*A*	*H*-2^a*H*-2^a	20	*A*	*H*-2^a*H*-2^a	2/16	12·5
DSWB	*A* × *ASW* F_1	*H*-2^a*H*-2^s	~ 5 × 10^7	*S4A*	*A*	*H*-2^a*H*-2^a	20	*A*	*H*-2^a*H*-2^a	15/20	75
—	—	—	—	*S4A*	*A*	*H*-2^a*H*-2^a	200	*A*	*H*-2^a*H*-2^a	13/16	81
DSWB	*A* × *ASW* F_1	*H*-2^a*H*-2^s	~ 5 × 10^7	*S4A*	*A*	*H*-2^a*H*-2^a	200	*A*	*H*-2^a*H*-2^a	20/20	100
MSWG	*A* × *ASW* F_1	*H*-2^a*H*-2^s	~ 5 × 10^7	—	—	—	—	*A*	*H*-2^a*H*-2^a	0/12	0
MSWG	*A* × *ASW* F_1	*H*-2^a*H*-2^s	~ 5 × 10^7	—	—	—	—	*A* × *ASW* F_1	*H*-2^a*H*-2^s	8/8	100
—	—	—	—	*S6A*	*A*	*H*-2^a*H*-2^a	20	*A*	*H*-2^a*H*-2^a	2/12	17
MSWG	*A* × *ASW* F_1	*H*-2^a*H*-2^s	~ 5 × 10^7	*S6A*	*A*	*H*-2^a*H*-2^a	20	*A*	*H*-2^a*H*-2^a	6/11	55
—	—	—	—	*S6A*	*A*	*H*-2^a*H*-2^a	200	*A*	*H*-2^a*H*-2^a	14/16	88
MSWG	*A* × *ASW* F_1	*H*-2^a*H*-2^s	~ 5 × 10^7	*S6A*	*A*	*H*-2^a*H*-2^a	200	*A*	*H*-2^a*H*-2^a	15/15	100

a few generations of transfer. These were excluded from the present experiments.

The 'stable' tumours that grow only in F_1 hybrids of the original genetic composition would lend themselves ideally to mutation studies (compare ref. 3), provided that certain basic conditions can be fulfilled. A tumour arising in an *A* × *A.SW* F_1 hybrid (genotype: *H*-2^a*H*-2^s) would be unable to grow in the parental *A*-line (genotype *H*-2^a*H*-2^a), unless a mutation occurred from *H*-2^s to *H*-2^a in one of the tumour cells. Such a mutant would have an absolute selective advantage when the population is tested for growth in the *A*-strain, where it would give rise to a progressively growing tumour, while all cells of the original type would be destroyed by the host. It would be still quite unable to grow in the other parental line (*A.SW*, genotype *H*-2^s*H*-2^s). Such a system would have the unique quality of making detectable a single gene mutation occurring in a single cell within a large neoplastic cell population.

It is not *a priori* certain, however, that the mutant would be able to survive under conditions in which the rest of the inoculated population, usually consisting of several million cells, is being destroyed simultaneously by an intensive and efficient host reaction. In spite of its favourable genetic composition, the mutant cell or its derived clone may be damaged by the host reaction or by toxic products of the damaged and killed tumour cells in a non-specific way. If this were the case, rare mutations would scarcely be detectable in such a system. Because of this possibility, it was considered necessary to carry out model experiments in order to investigate the survival of known mixtures of compatible and incompatible tumour cells, differing by a single allele at the *H*-2 locus, after inoculation into mice of known genotype. The main results are described here.

Sarcomas induced by the subcutaneous injection of methylcholanthrene were used in their early transfer generations (less than 10). Cell suspensions were made by forcing the freshly removed, ice-cooled tumour tissue through stainless steel nets into Krebs–Ringer phosphate solution, containing 0·25 per cent gelatin and 0·5 per cent glucose. Cells were enumerated in a hæmocytometer and appropriate dilutions were made in the same solution. A known large number of tumour cells that had originated in an *A* × *A.SW* F_1 hybrid were then mixed with a known small number of similarly suspended cells derived from the parental *A*-strain. The mixtures were inoculated subcutaneously into *A* mice. Control *A* mice were inoculated either with cells of the F_1 tumour alone or with cells of the *A* tumour alone. The same cell dosages were used in the controls as there were in each of the mixed inocula. Mice of both sexes were used, weighing 20–25 gm. They were all derived from the single-line inbred nucleus of the strain, kept by continuous brother-to-sister mating. The inoculated animals were observed for tumour formation by regular palpations, followed by calliper measurements of the progressively growing neoplasms and by recording the time elapsing until the death of the host from the tumour. Mice without tumours were considered negative after an observation period of four months.

The results of some representative experiments are shown in Table 1. It appears that even in cases where the compatible (*H*-2^a*H*-2^a) fraction of the inoculated cell population was as small as 4×10^{-7}, it survived not only as well as, but even much better than, in the controls, in spite of the simultaneous destruction of the overwhelming majority (genotype: *H*-2^a*H*-2^s) by the intense homograft reaction of the *H*-2^a*H*-2^a host. Indeed, it seems as if the former cell type would have been stimulated in its growth considerably by some factor involved in the destruction of the latter. This was manifested by an increased percentage of mice killed by progressively growing tumours, and by a more rapid development of the neoplasms and a reduced survival time of the tumour-bearing animals, when mice receiving the mixture of compatible and incompatible cells were compared with animals inoculated with the same number of compatible cells alone. The mechanism of this stimulating effect is not clear. It could be due conceivably to products liberated by the incompatible tumour cells in the course of their destruction or to the homograft reaction itself. A similar stimulating effect has been found by Révész[4] in experiments in which mixtures of living tumour cells and cells of the same tumour line but killed by X-rays were inoculated into compatible hosts. Since his system also involves, besides disintegration of killed cells, an intense inflammatory reaction of the host, it does not distinguish between the possibilities of stimulation by cell products or by the host response.

The stimulating effect does not seem to be specific for the cells of the *H*-2^a*H*-2^s genotype, or for methylcholanthrene-induced homologous tumours, since it occurred in a similar fashion when a small number of *S4A* tumour cells, indigenous to the *A*-strain, were

mixed with a large proportion of cells derived from a mammary carcinoma of the *DBA* strain, and inoculated into *A*-mice. Preliminary experiments indicate that there is no stimulating (or inhibiting) effect if the compatible and incompatible cells respectively are inoculated at two different sites in the same recipient animal. Further studies on the mechanism of the stimulating effect are in progress.

These findings have three main implications. First, they emphasize the extreme specificity exhibited by the homograft reaction and its ability to 'recognize' a very small number of cells of compatible genotype within a large population of incompatible cells of similar morphological origin and differing from the former only with regard to a single gene locus. Second, they justify the expectation that the present tumour–host system will enable the detection of a single mutation at a single histo-compatibility locus in a single tumour cell. Finally, similarly to the experiments of Révész[4], they indicate that the destruction of a very large proportion of a tumour-cell population does not necessarily lead to the damage of the small surviving fraction, provided that the latter is genetically compatible with the host. The disintegration of the damaged cell fraction and the ensuing inflammatory response do not seem to increase the chances of the host destroying the surviving part of the population and being cured; on the contrary, they stimulate its growth. It seems that the host has no effective way of reacting against tumour cells of compatible genetic constitution, either in a specific or a non-specific way, at least when considering host–tumour systems similar to those used in the present experiments.

This work has been supported by research grants from the Swedish Cancer Society and Lotten Bohmans Fond.

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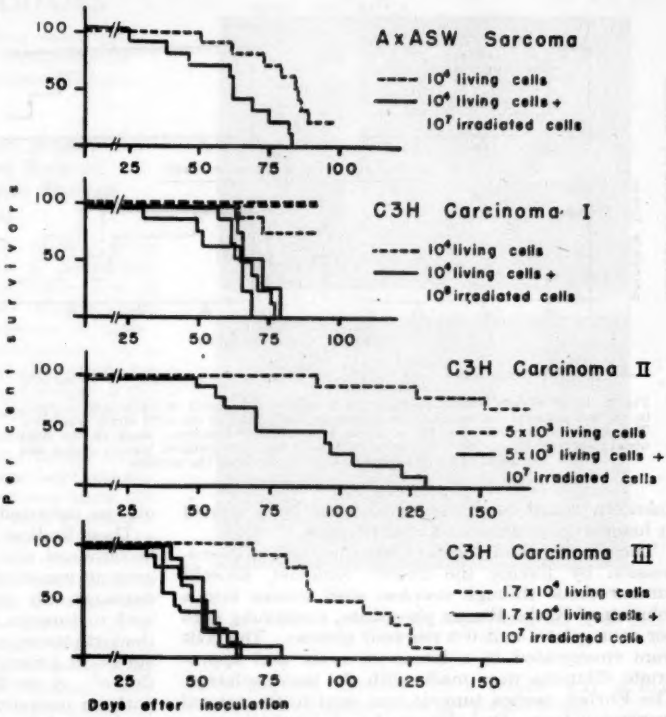

Fig. 1. Effect of cells lethally damaged by X-rays on admixed viable cells. Note higher incidence of progressively growing tumours and a reduction of survival-time in animals inoculated with mixture. Four different tumours were inoculated into mice of the original genotype

Effect of Tumour Cells killed by X-rays upon the Growth of Admixed Viable Cells

TUMOURS irradiated with sublethal X-ray doses can be schematically considered as containing two kinds of tumour cells, differing in their prospective reproductive potentialities. One fraction has been damaged irreversibly so as to lose the ability for continued reproduction. These cells may die immediately or after a number of cell divisions[1]. Another part of the cell population is composed of cells undamaged or damaged in a reversible way, and still capable of multiplying serially without restraint. The relative proportion of these two fractions is probably related to the X-ray dose, the inherent sensitivity of the cells and to various environmental conditions during irradiation.

Very little is known about the potential influence that the lethally damaged population may exert on the continued proliferation of the surviving fraction, either directly or through the host organism. It is conceivable that the dying cells may stimulate the growth of the survivors in a variety of ways; but it is equally possible that they inhibit them by toxic products or as a result of the intense local inflammatory reaction they induce in the host.

The problem was approached experimentally by mixing irreversibly damaged and viable mouse tumour cells in various proportions. Two main tumour types were used. The first group includes neoplasms that arose spontaneously or have been induced by carcinogens in mice of highly inbred strains or in F_1 hybrids produced by crossing two inbred strains. These tumours were used after a single generation of transfer into mice of the original genotype. Another category is represented by the Ehrlich ascites tumour that originated in a mouse of

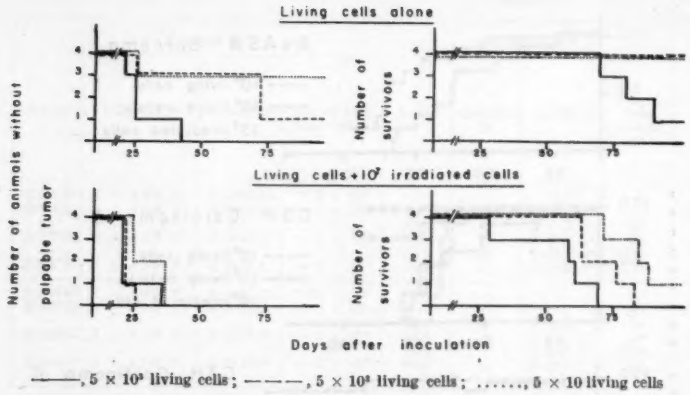
Living cells alone
Number of animals without palpable tumor
Number of survivors
Living cells + 10^7 irradiated cells
Days after inoculation
——, 5 × 10^3 living cells; — — —, 5 × 10^2 living cells; ....., 5 × 10 living cells

Fig. 2. Effect of cells lethally damaged by X-rays on the growth of viable cells admixed in various numbers. A spontaneous mammary carcinoma of the *C3H* strain was used. The curves on the left show the appearance of palpable tumours; those on the right denote survival time. Note higher incidence of tumours, reduced latency-period and decrease of survival-time in animals receiving the mixture

unknown genetic composition and has been carried in heterozygous animals for sixty years.

The various solid tumours were brought into suspension by forcing the freshly removed, ice-cold tumour tissue through stainless steel screens into a solution of Krebs–Ringer phosphate, containing 0·25 per cent gelatin and 0·5 per cent glucose. The cells were enumerated in a hæmocytometer and appropriate dilutions were made with the same solution. The Ehrlich ascites tumour was used in its natural suspension form. One aliquot of each suspension was irradiated *in vitro* with 12,000 r. in a nitrogen atmosphere, a dose far above what is necessary for the complete inactivation of all tumours used in the present study. A known number of irradiated cells was mixed in various proportions with an untreated aliquot of the same suspension. Three groups of mice were inoculated. Group *A* (6–10 mice) received only lethally damaged cells. Group *B* (10–30 mice) was inoculated with untreated cells alone. Group *C* (10–30 mice) received mixtures of the two cell types in various proportions. The number of lethally damaged cells was kept constant, and the untreated cells were admixed in the same number as used for the inoculation of group *B*. The latency-period elapsing before the appearance of palpable tumours was determined and the survival-time of the tumour-bearing animals was recorded. Mice surviving without tumours were kept under observation for three to six months. In the case of the Ehrlich ascites tumour, the total number of free tumour cells in the peritoneal cavity was also followed by quantitative growth curves[2].

No growth was obtained in any mouse belonging to group *A*. When comparing groups *B* and *C*, the lethally damaged cells were found to exert an intense stimulating effect on the proliferation of viable tumour cells of the first category (consisting of four different spontaneous mammary carcinomas of the *C3H* strain and a methylcholanthrene-induced sarcoma of the $A \times ASW$ F_1 hybrid combination). This was most apparent when the number of viable cells was small (10^2–10^3) compared to the number of damaged cells (about 10^7). In such cases, group *C* showed a reduced latency-period and a decreased survival-time of the tumour-bearing animals when compared to group *B* (Figs. 1 and 2).

Different results were obtained with the Ehrlich ascites tumour[3]. When measuring the growth curve of intraperitoneally inoculated tumour cells, an analogous stimulation was found upon mixing 2×10^6 living cells with 20×10^6 lethally damaged cells. If a small viable inoculum was used instead (100 cells) and the number of damaged cells was kept constant, a pronounced inhibition was observed, however. While 100 cells alone led to progressively growing tumours in all mice, the presence of dead cells completely prevented their development. This was found to be due to an active immunization of the host against the immunogenetically foreign Ehrlich tumour by the cells damaged by X-rays, thus preventing the small viable fraction from reaching an irreversible population-level.

These findings indicate that fallacious results may be obtained with so-called non-specific tumours that grow in genetically foreign hosts. A treatment that damages only one part of the cell population may lead to tumour regression after receiving help from the histo-incompatibility reaction of the mouse. This agrees in principle with the findings of Cohen and Cohen[3]. A similar situation does not seem to occur with an immunogenetically compatible tumour–host system, where partial damage of the population appears to stimulate the growth of the survivors in all cases. This occurs in spite of the fact that the host reacts with an intense and histologically very impressive local inflammatory reaction against the presence of damaged and killed tumour cells[4]. This reaction is nevertheless unable to destroy, or substantially damage, compatible and viable tumour cells. In this respect it is similar to the homograft reaction[5].

In our continued studies about the nature of the stimulating effect exerted by dead cells we are trying to distinguish between the following possibilities: (1) specific stimulation by homologous cell products[6]; (2) a 'feeder effect'[7], in which the dead cells release essential nutrients; and (3) stimulation through provoking an inflammatory response and/or vascularization from the side of the host.

I wish to thank Dr. G. Klein for many valuable discussions, and Miss L. Hennings for her assistance in the experimental work. This work was supported by grants to Dr. G. Klein from the Swedish Cancer Society and Konung Gustaf V:s Jubileumsfond.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Incorporation of Radioactive Aspartic Acid into the Proteins and Related Fractions in Mice bearing the Ehrlich Ascites Carcinoma

In Zamecnik's laboratory, Frantz *et al.*[1], using dinitrophenol, found in liver slices a parallelism between the inhibition of phosphorylation and of amino-acid incorporation. Siekevitz[2] demonstrated in a cell-free system a relation between oxidative phosphorylation and amino-acid incorporation in a crude rat-liver homogenate. Hoagland[3] concluded from his experiments that the carboxyl groups of the amino-acids are activated by adenosine triphosphate, and that the activated amino-acyl groups are bound through an adenosine monophosphate bridge to an enzyme acting as an intermediate amino-acyl transfer compound. However, such intermediates have not yet been isolated and identified. In their systems it was not possible to 'exchange out' the carbon-14 labelled amino-acids with large quantities of unlabelled amino-acids; thus the incorporation was different from the exchange process described by Gale and Folkes[4] in fragmented *Staphylococcus aureus*. J. T. Park[5] has isolated uridine-5'-phosphate derivatives containing an amino-sugar and amino-acids from extracts of *Staphylococcus aureus* treated with penicillin. On the basis of these and a great number of other experiments, Borsook[6] proposed a hypothesis for the mechanism of biosynthesis: the carboxyl groups of free amino-acids are first activated by an enzyme system dependent on adenosine triphosphate. They are then transported to a nucleic acid template by an unknown mechanism and are arranged in a specific sequence, the amino-acids being attached to the phosphate of nucleic acid by their carboxyl groups. On this template, the amino-acids are then linked by peptide bonds through the action of another enzyme, and the protein molecule peels off the template.

The following work is an attempt to find and investigate any labelled compounds of relatively low molecular weight which might be formed on administration of a ^{14}C-labelled amino-acid to mice bearing the Ehrlich ascites carcinoma. The tumours were produced by intraperitoneal transfer of approximately 10^7 tumour cells into each mouse from stock mice (C_{57}Black × C_3HF_1). After the tumour has grown for four days, 0·1 ml. of a solution of L-aspartic acid-^{14}C (generally labelled, Radiochemical Centre, Amersham) containing 8·33 μc. (in 0·16 mgm.) was injected intraperitoneally into each of the ten mice.

The mice were killed 15 min. after the injection, the livers pooled and kept at −78° C., and from the ascitic fluid the tumour cells were separated by a short centrifugation at 0°, and were then mixed with an equal volume of 0·66 *N* perchloric acid at 0°. After homogenizing and standing for 3 hr. at 0°, the precipitate was centrifuged off and the supernatant neutralized with potassium hydroxide at 0°. After the potassium perchlorate was centrifuged off, a clear, neutral solution was obtained, practically free of perchloric acid (1 per cent). This solution will be called the cell extract. In a similar way a liver extract was obtained from the pooled livers.

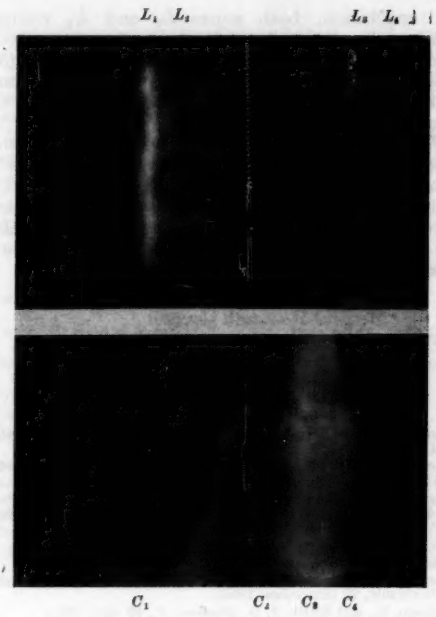

Fig. 1. Autoradiograms of the electrophorograms of the liver extract (*L*) and the cell extract (*C*)

These extracts were submitted to paper electrophoresis (Whatman 3 *MM*, veronal buffer *p*H 8·6, 300 V./12 m.amp. = 10 V./cm., 210 min.). After drying in a current of warm air (40°), autoradiography revealed four labelled zones moving to the positive pole (Fig. 1).

It is interesting to note the differences in the strength and the electrophoretic mobility of the fractions L_3 and C_2; although, at this stage, it is not certain that this difference can be attributed to a particular state of the mechanism of biosynthesis in the tumour cell.

Zone L_4 was eluted and was run in ammonium sulphate–*iso*propanol[7]. The ultra-violet print shows two spots with R_F 0·37 and 0·81 respectively. Autoradiography showed that only the spot with R_F 0·81 contained carbon-14 activity. This spot on hydrolysis with *N* hydrochloric acid (100°, 1 hr.) gave a substance which ran in *iso*propanol.hydrochloric acid[8] with the same speed as uridylic acid (R_F 0·63) and had the same ultra-violet spectrum in neutral, acid and alkaline solution. It also gave a ninhydrin-positive spot which ran with the same speed (R_F 0·36) as aspartic acid in this same solvent. The carbon-14 activity was contained in the aspartic acid spot, while the uridylic acid spot was inactive. The other spot (R_F 0·37 in ammonium sulphate–*iso*propanol), which did not contain carbon-14 activity, was identified as adenylic acid.

Zone L_3 gave in ammonium sulphate/*iso*propanol two spots with R_F 0·38 and 0·70 respectively. All the carbon-14 activity was contained in the R_F 0·70 spot. It had the same ultra-violet spectrum as uridylic acid. In *tert*-butanol/hydrochloric acid[9] the spot runs with the front, whereas uridylic acid under the same conditions has R_F 0·78.

In conclusion, both zones L_4 and L_3 contain inactive adenylic acid, while the carbon-14 activity is contained in a uridylic acid–aspartic acid compound, which in the substance of zone L_4 has R_F 0·81 and in that of zone L_3 has R_F 0·70 when run under the same conditions.

A proof of the constitution of the uridylic acid–aspartic acid compounds must await the results of further investigations at present in progress. The identification of the other zones obtained by electrophoresis is also proceeding. Fuller details, together with a consideration of possible biochemical implications, will be given in another paper.

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Identity of the Phosphodiesterase and Deoxyribonuclease in Rattle-Snake Venom

As part of a programme on different phosphoesterases, the behaviour of the phosphodiesterase activity in rattle-snake venom has been studied by anion exchange chromatography. The adsorbent was the diethylaminoethyl cellulose of Sober and Peterson[1], and in order to utilize possible displacement effects a one-step-elution technique was used. This procedure has been applied earlier for the detection and separation of two acid phosphomonoesterases from horse radish[2,3]. However, the chromatographic experiments described here differ owing to the fact that we now have been working at a *p*H near the *pK* of the ion exchanger[1]. Although the investigation is being continued, this communication may be justified by two unexpected findings: the venom seems to contain two phosphodiesterases and both of them digest deoxyribonucleic acid.

A typical experiment, pointing toward these conclusions, was carried out in the following way. A column (22 cm. × 1·04 cm.) with 19 ml. of diethylaminoethyl cellulose was brought into equilibrium with 0·02 *M* tris(hydroxymethyl)aminomethane – hydrochloric acid buffer[4] ('Sigma 7–9, biochemical buffer', Sigma Chemical Co., St. Louis 18, Mo.) of *p*H 8·9 (the starting buffer). Of the freeze-dried venom from *Crotalus adamanteus* (Ross Allen's Reptile Institute, Silver Springs, Florida), 40 mgm. was dissolved in 2 ml. of starting buffer. After centrifugation, which removes some less-soluble globulin material, the solution was applied to the column. The chromatogram was then developed with a 0·33 *M* tris(hydroxymethyl)aminomethane – hydrochloric acid buffer of *p*H 8·9 using a water pressure of 28 cm. The first 2 ml. were discarded and fractions

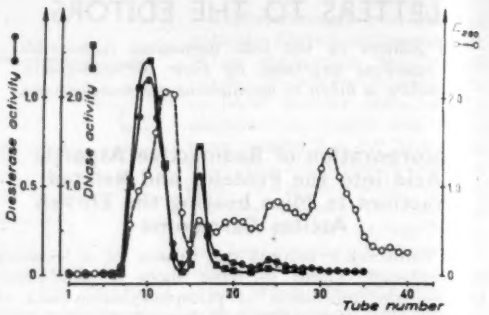

Fig. 1. Chromatography of rattle-snake venom on diethylaminoethyl cellulose. Open circles represent extinction at 280 mμ, crossed circles the activity toward calcium (bis(*p*-nitrophenyl)-phosphate)$_2$ expressed as millimoles of nitrophenol liberated per l. of incubation mixture and crossed squares the deoxyribonuclease activity expressed as liberated extinction at 260 mμ

were then collected every 8 min. with volumes of around 0·8 ml. The temperature was 4°.

The effluent was analysed for protein content, measured as extinction at 280 mμ in a Beckman *DU* spectrophotometer, and for phosphodiesterase and deoxyribonuclease activity. Calcium (bis(*p*-nitrophenyl)-phosphate)$_2$ (for preparation, see ref. 5) was used as substrate for the diesterase activity and the procedure was the same as that utilized for the determination of a monoesterase[6].

The deoxyribonuclease activity was estimated as the acid-soluble nucleotide material liberated from a 0·6 per cent solution of deoxyribonucleic acid, prepared according to Kay *et al.*[7], and dialysed against 0·05 *M* tris(hydroxymethyl)aminomethane–hydrochloric acid buffer of *p*H 8·9. Of this substrate solution, 100 μl. was incubated with 25 μl. from the different fractions for 60 min. at 37°. The reaction was stopped with 1 ml. of 0·01 *M* lanthanum nitrate in 0·1 *M* hydrochloric acid; the precipitated deoxyribonucleic acid was centrifuged down and the extinction at 260 mμ of the supernatant fluid read against a blank was taken as the deoxyribonuclease activity.

The result from this experiment is shown in Fig. 1. As can be seen, both phosphodiesterase and the deoxyribonuclease activities (crossed circles and crossed squares, respectively) show two almost coinciding peaks. The question whether or not these two peaks correspond to two different enzymes will be discussed elsewhere together with additional chromatographic experiments.

The possible identity of the phosphodiesterase and the deoxyribonuclease activities is indicated by the striking coincidence of the curves in Fig. 1, which is even better than the figure shows. This depends on the fact that, while the splitting of calcium (bis(*p*-nitrophenyl)phosphate)$_2$ follows a straight line with increasing amount of enzyme, the corresponding relation for the digestion of deoxyribonucleic acid has a lag part in the beginning.

The coincidence has been confirmed in another chromatographic experiment, in which the conditions were only slightly different from the experiment shown in Fig. 1, but using as substrate deoxyribonucleic acid prepared according to Hammarsten–Sevag[8,9]. Preliminary determinations have also shown the *p*H optimum for the deoxyribonuclease activity to be around 9, which is similar to the optimum of the diesterase activity.

Table 1. Heat Inactivation of Deoxyribonuclease and Phosphodiesterase Activity (Arbitrary Units)

Time in min.	Temp. 55° C.			Temp. 57° C.		
	Diesterase	Deoxyribonuclease	Ratio of diesterase to deoxyribonuclease	Diesterase	Deoxyribonuclease	Ratio of diesterase to deoxyribonuclease
0	965 987	868 900	1·10	815 824	530 570	1·49
5	960 936	852 766	1·17			
15	872 875	767 780	1·13	750 720	480 520	1·47
30	821 787	744 756	1·07	695 686	440 440	1·57
45	866 821	706 698	1·20			
60	747 809	694 648	1·16	463 460	300 305	1·53
75	764 780	608 606	1·21			
90	750 737	616 622	1·20			

The classical view on the enzymatic degradation of deoxyribonucleic acid[10] has been that an enzyme called deoxyribonuclease acts on the macro molecule, splitting it mainly into oligonucleotides. Another enzyme, named phosphodiesterase, then acts on the oligonucleotides, hydrolysing them nearly completely to mononucleotides.

However, the specificity of different phosphodiesterases has been a subject of discussion. Privat De Garilhe and Laskowski[5] pointed out that their purified phosphodiesterase from rattle-snake venom acts on both calcium(bis(*p*-nitrophenyl)phosphate)$_2$ and oligonucleotides, but that no action could be observed toward "a highly polymerized DNA". Brawerman and Chargaff[11], when studying barley phosphodiesterase, doubt that the same enzyme is acting on different substrates of low molecular weight, while Schmidt[10] classified the phosphodiesterase from different venoms as "unspecific".

As mentioned earlier[3], the chromatographic procedure used here gives only a preliminary group separation and, therefore, a limited degree of purification. The enzyme studied by Privat De Garilhe and Laskowski[5], which should be identical with ours, is probably purer than our preparation. It might thus be possible that our enzyme preparation contains two different enzymes, one acting on deoxyribonucleic acid and one on calcium(bis(*p*-nitrophenyl)phosphate)$_2$.

In order to check this hypothesis the heat inactivation of the phosphodiesterase and deoxyribonuclease activities has been followed. Chromatographically purified samples, similar to the one in tube 10, Fig. 1, were kept at temperatures between 50° and 58°, and at different times samples were taken out and incubated with the two substrates. The experiment at 50° showed no measurable inactivation, while at 58° precipitation caused difficulties in obtaining reproducible figures for the activities. The results from two other series are given in Table 1.

The coincident inactivation demonstrated here, together with the striking parallelism between the two activity curves in Fig. 1, thus indicate that the same enzyme is responsible for the action on both calcium(bis(*p*-nitrophenyl)phosphate)$_2$ and macromolecular deoxyribonucleic acid.

This investigation is financially supported by grants from the Rockefeller Foundation and the Swedish Cancer Society.

We wish to express our thanks to Profs. E. Hammarsten and A. Tiselius for their stimulating interest.

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Sialoadenectomy and Thyroid Response to Thyrotrophic Hormone

Previous observations[1–3] have been reported which indicated the salivary glands to be capable of modifying thyroid activity, such modification being made apparent by a reduced iodine-131 uptake, reduced turnover rate and a reduction in the thyroid-stimulating hormone titre as determined by the method of Barell and Holmgren[4]. Since sialoadenectomy imposed upon hypophysectomized rats did not result in different thyroid activities[2], it was postulated that the salivary glands, that is, substance(s) elaborated therefrom, could act upon the thyroid (1) in conjunction with the hypophysis (synergistic action) or (2) upon the hypophysis directly. In an attempt to learn something of the mode of action of the salivary-gland secretions on thyroid activity, the response of sialoadenectomized, hypophysectomized and intact animals to parenteral thyroid-stimulating hormone was studied. Animal feeding, care, size, strain, pre- and post-operative treatment were as previously described[1–3]. There were not less than eight and no more than twelve rats in any experimental or control group. The radioactivity assays were performed in the same manner as they were in previous studies.

Preliminary experimentation (Table 1) showed that the thyroids of intact rats would take up 16·3 per cent more phosphorus-32 when treated with thyroid-stimulating hormone (50 μgm. per 100 gm. body-weight), whereas the thyroids of sialoadenectomized rats take up 53·7 per cent more phosphorus-32 than do their non-treated controls in response to the same dose. A second experiment was performed, the results of which are indicated in Table 2. Thyrotrophic hormone increased the phosphorus-32 activity in the intact animal thyroids 14·2 per cent over base-line values; in the sialex animals a 132 per cent increase was observed with the 50 μgm. dose, whereas with a 100 μgm. dose,

Table 1. Effect of Parenteral Thyrotrophic Hormone on the Phosphorus-32 Uptake of Intact and Sialoadenectomized Rats

	Counts/min. phosphorus-32 per mgm. thyroid
Intact	164·3 ± 41·7*
Intact + thyroid-stimulating hormone (50 μgm./100 gm. body-weight)	191·2 ± 28·9
Sialoadenectomized	122·7 ± 29·4
Sialoadenectomized + thyroid-stimulating hormone (50 μgm./100 gm. body-weight)	188·7 ± 41·8

* Standard error of the mean

Table 2. Titre of Thyroid-stimulating Hormone and the Effect of Parenteral Hormone measured by Phosphorus-32 Uptake Two Hours after Injection of 50 μc. Radioactive Phosphate

Group	Average counts per min./mgm.
Intact control	162·0 ± 12·9*
Intact control + thyroid-stimulating hormone (50 μgm./100 gm. body-weight 2 hr. before phosphorus-32)	184·9 ± 19·3
Sialoadenectomized	89·7 ± 4·0
Sialoadenectomized + thyroid-stimulating hormone (50 μgm./100 gm. body-weight 2 hr. before phosphorus-32)	232·0 ± 11·2
Sialoadenectomized + thyroid-stimulating hormone (100 μgm./100 gm. body-weight 2 hr. before phosphorus-32)	392·9 ± 42·3
Hypophysectomized	28·3 ± 3·0
Hypophysectomized + thyroid-stimulating hormone (50 μgm./100 gm. body-weight 2 hr. before phosphorus-32)	162·3 ± 10·9
Hypophysectomized + sialoadenectomized	24·8 ± 1·6

* Standard error of the mean

Table 3. Comparison of the Average Weight of Rat Thyroids

Group	Average thyroid weight (mgm.)	P value compared with controls
Intact controls	14·0 ± 0·7*	—
Sialoadenectomized	12·1 ± 0·3	0·018
Hypophysectomized	11·7 ± 0·5	0·015
Hypox + sialex	11·9 ± 0·6	0·030

* Standard error of the mean

a 341 per cent increase was noted. Hypophysectomized animals responded to thyroid-stimulating hormone in the manner expected, showing a 472 per cent increase in phosphorus-32 activity in the thyroid. The titre of thyroid-stimulating hormone in hypophysectomized–sialoadenectomized rats was found to be essentially the same as that of hypophysectomized rats, an observation in agreement with previous findings[2]. The data presented thus far are indicative of some regulatory function of the secretions of the salivary glands on thyroid activity, probably involving the control of the action of thyroid-stimulating hormone on thyroid tissue or by an effect on the thyroid cells which prepares them for the action of the hormone. The greater response of sialoadenectomized animals to the hormone, we feel, indicates that there is such a controlling mechanism. However, the role of the hypophysis appears to be dominant in the processes involved since its removal greatly reduces the observable effects of sialoadenectomy. It is quite obvious that the secretions of both glands must complement each other in sequential or parallel actions.

Analysis of the average weights of the thyroids from animals of comparable size discloses an interesting and collaborative observation. As indicated in Table 3, a significant difference appears to exist between the sizes of the thyroids of intact, sialoadenectomized, hypophysectomized and hypophysectomized–sialoadenectomized rats. Whether these changes are due to a relationship between the hormones or to metabolic disturbances induced by alterations in hormone patterns is not yet known[5].

This study was sponsored by a grant (*C*-1881) from the National Institutes of Health, Bethesda.

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Antifibromatogenic Potency of 9α-fluoro Derivatives of Progesterone

The use of halogenated pregnene derivatives, especially of 9α-fluoro-hydrocortisone, has been undoubtedly the greatest recent advance in the experimental pharmacology of steroids, as evidenced by the outstanding work of Fried and his colleagues[1] on the various potencies of this corticoid. In the present communication we discuss results obtained in guinea pigs, in which we tried to prevent the abdominal fibromatogenic action of œstrogen; other anticœstrogenic potencies also have been studied.

Antifibromatogenic activity and likewise other anticœstrogenic potencies of progesterone are known to diminish when oxidation is performed[2] at C_{21}, C_{11} and C_{17}. Diminution of these potencies is striking with oxidation at C_{11} (11β-hydroxyprogesterone) and, even more pronouncedly, with oxidation at C_{17} (17α-hydroxyprogesterone)[3]. How will the 9α-fluoro-derivatives of these compounds behave?

Pellets containing 20–80 per cent of 9α-fluoro-11β-hydroxyprogesterone mixed with cholesterol were implanted beneath the skin of castrated female guinea pigs. Pellets of œstradiol also were implanted. Complete inhibition of large abdominal fibroids was

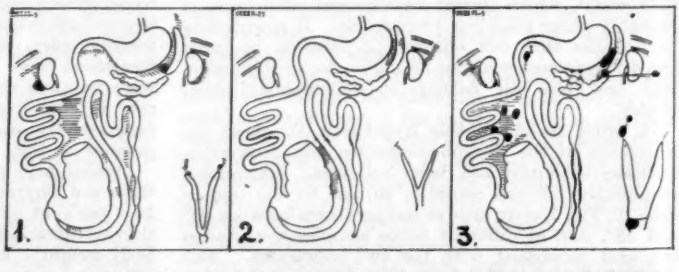

Fig. 1. Maximal fibrous tumoral reaction with œstrogen and 69 μgm. of 11β-hydroxyprogesterone. Large tumours (solid black) behind the kidney and on the spleen, apical tumours of the uterus; fibrous strands (shaded areas) in the mesentery, hilus of the spleen and behind the kidneys. Fibrous tumoral effect, 7 (average, 2·7), ref. 2. Uterine weight 2·3 gm.

Fig. 2. Maximal fibrous tumoral reaction with œstrogen and 3 μgm. of 9α-fluoro-11β-hydroxyprogesterone. Fibrous strands in the mesentery and the hilus of the spleen. Tiny nodule of the latter. Fibrous tumoral effect, 2 (average: 1·3; Table 1). Uterine weight, 1·6 gm.

Fig. 3. Maximal fibrous tumoral reaction with œstrogen and 59 μgm. of 9α-fluoro-11β,17α-dihydroxyprogesterone. Large tumours and fibrous strands. Fibrous tumoral effect, 12 (average: 5·7; Table 1). Uterine weight, 5·1 gm.

Table 1. EXPERIMENTS ON 27 CASTRATED FEMALE GUINEA PIGS RECEIVING DURING THREE MONTHS OESTRADIOL AND 9α-FLUORO-11β-HYDROXYPROGESTERONE. EXPERIMENTS ON 7 ANIMALS RECEIVING 11β,17α-DIHYDROXYPROGESTERONE

Group	No. of animals	Œstradiol (μgm./day)	9α-Fluoro-progesterone derivatives (μgm./day)*	Fibrous tumoral effect (ref. 2)	Coeff. Q_{1-3} (ref. 2)	Uterine weight (gm.)	No. of pellets and concentration of 9α-fluoro-hydroxyprogesterone
			11β-hydroxy				
I	2	54–64	0·7	4·0 (3·5–4·5)	1·0	2·0 (2·0–2·0)	1; 20 per cent
II	6	47–73	2·2†	1·3 (0·5–2·0)	0	2·2 (1·6–3·5)	1; 20 ,,
III	7	34–52	8	1·1 (0·5–1·5)	0	1·6 (1·1–2·8)	1; 40 ,,
IV	5	38–54	16	1·0 (0·5–1·0)	0	1·7 (0·8–2·3)	2; 40 ,,
V	7	37–66	65	1·1 (0·5–2·0)	0	1·6 (0·9–2·3)	1; 80 ,,
			11β,17α-dihydroxy				
VI	7	36–61	56	5·7 (1·0–12)	1·9	5·1 (3·0–8·0)	1; 100 ,,

* Absorption per day was calculated from loss of weight of the pellet during the experiment, on the assumption of non-selective absorption, as with the mixture of non-halogenated steroids (ref. 7). Fluorine was determined by the micromethod of Kolthoff and Stamsby (ref. 8). The method was not sufficient to establish any difference or lack of difference between the percentage of fluorine in non-used and used tablets. But the comparative figures of absorption per day in column 4 are not in favour of selective absorption. On the assumption of selective absorption, these figures should be multiplied by 5, with 20 per cent pellets (11 μgm./day); by 2·5, with 40 per cent pellets (20 μgm./day); by 1·25 with 80 per cent pellets (80 μgm./day); a drop from 80 μgm./day with 80 per cent pellets to 20, and 11 μgm./day with 40 per cent and 20 per cent pellets, is not possible with selective absorption (ref. 7).

† Range: 1·8–2·6 μgm./day.

obtained with as little as 2·2 (1·8–2·6) μgm./day of the halogenated compound (Table 1; Fig. 2). An average of 15 μgm. of progesterone was necessary to produce a similar effect[3,4]. Thus, the antifibromatogenic potency of 9α-fluoro-11β-hydroxyprogesterone is about six to seven times that of progesterone. But the increase of activity through halogenation appears to be even more striking when comparing 9α-fluoro-11β-hydroxyprogesterone with 11β-hydroxyprogesterone. With as much as 78 and even 490 μgm./day of the latter, prevention is still less pronounced than with 2·2 μgm. of the 9α-fluoro-compound (Table 2; comp. also Figs. 1 and 2). Halogenation with fluorine increases antifibromatogenic activity about two hundred times. (Should the assumption of non-selective absorption (see Table 1) be erroneous, increase of potency through halogenation with fluorine would be only about fifty times.)

As to the antihysterotrophic potency, the difference between the two compounds is not so striking, but also fully evident: with an average of 8 μgm./day of 9α-fluoro-11β-hydroxyprogesterone, the same antihysterotrophic effect is obtained as with 78 μgm./day of the non-halogenated compound[2]. It was the same with the antiluteinizing action (unpublished work). An increase of the antihysterotrophic activity of 11β-hydroxyprogesterone through halogenation had already been demonstrated in the extensive work of Huggins and Jensen[5] with the uterus of hypophysectomized rats. A considerably greater effect was obtained by these authorities with the injection of 250 μgm./day of the fluoro-compound than with the injection of 1,000 μgm./day of the non-halogenated compound.

Experiments were performed also with 9α-fluoro-11β,17α-dihydroxyprogesterone. As seen from Table 1, the antifibromatogenic and antihysterotrophic potencies of this compound are greatly inferior to those of 9α-fluoro-11β-hydroxyprogesterone. No prevention of the fibromatogenic or hysterotrophic action of œstrogen was obtained with as much as 56 μgm./day, that is, with an amount twenty to thirty times greater than the already highly active dose of 9α-fluoro-11β-hydroxyprogesterone (1·8–2·6 μgm./day). This finding gives new evidence of the deleterious influence of oxidation at C_{17} in the α-position on the antiœstrogenic potencies of progesterone derivatives (comp. Figs. 2 and 3), an influence which was already so evident with 17α-hydroxyprogesterone[3]. Indeed, an antihysterotrophic activity has been obtained in the rat with large quantities of 9α-fluoro-hydrocortisone[5,6], that is, notwithstanding the presence of OH in C_{17}-α.

The enormous increase of the antifibromatogenic activity due to halogenation with fluorine justifies the question whether use of this procedure could be used in trials with the antifibromatogenic and antitumorigenic action of steroids in those cases in which hitherto progesterone has been used. Similar clinical trials would be apparently handicapped by the fact that 9α-fluoro-11β-hydroxyprogesterone has also cortical activities[1].

Thanks are due to Dr. Josef Fried, of the Squibb Institute for Medical Research, New Brunswick, N.J., for a generous supply of halogenated pregnene derivatives.

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Table 2. COMPARATIVE ANTIFIBROMATOGENIC POTENCY OF THREE STEROIDS IN GUINEA PIGS

	Antifibromatogenic steroid	μgm. per day	Fibrous tumoral effect	Coeff. Q_{1-3}	Antifibromatogenic potency
A	Progesterone (ref. 4)	9	3·6	1	
B	9α-fluoro-11β-hydroxyprogesterone	15	1·5	0	1·00
		2·2	1·3	0	6·00–7·00
C	11β-hydroxyprogesterone (ref. 2)	78	2·7	0·7	
		490	2·2	0·2	<0·03

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Demonstration of Acetylcholinesterase on Motor End-plates after embedding in Polyethylene Glycol

Polyethylene glycol seems to be particularly suitable as an embedding medium for demonstrating several enzymes. Certain polyethylene glycols and their monostearates (polyethylene glycol 1,000 and 'Nonex 63', both obtainable from Gemec Chemicals Co., 120 Moorgate, London, E.C.2; 'Polywachs 1,000' and 'Produkt *V* 2,275'. both manufactured by C. W. H. Marl, Kreis Recklinghausen, Germany) are available as wax-like compounds, which in consistency strongly resemble paraffin, but have a lower melting point and are soluble in water, are very suitable for demonstrating non- or slightly diffusible enzymes. The polyethylene glycol embedding has the great advantage over paraffin embedding that the procedure takes only a short period of time (4–5 hr.) and the enzyme is exposed for 2–3 hr. at 42° C. In addition, substances such as ethanol which may inactivate the enzymes can be avoided.

The histochemical localization of acetylcholinesterase was studied on the motor end-plates of the guinea pig's intercostal muscle. Polyethylene glycol embedding was performed by the method of Miles and Linder[1], and the Koelle acetylthiocholine iodide method modified by Gerebtzoff[2] was used to demonstrate acetylcholinesterase. The intensity of the reaction seems to be quite satisfactory, structural details are well distinguished, and diffusion artefacts are negligible even after incubation for 40 min., as can be seen in Fig. 1*a* and *b*.

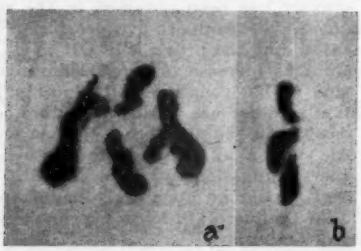

Fig. 1. Motor end-plate of the guinea pig's intercostal muscle: (*a*) in the plane of the section; (*b*) lateral view

An advantage of our method over frozen sections is that it allows sections to be cut as thin as 4–5μ and to be handled on slides during the histochemical procedure; the reaction can be carried out even several days after embedding. Further, it permits the preparation of serial sections, some of which may then serve for other histochemical reactions or stainings. An inconvenience in using polyethyleneglycol as an embedding medium is the hygroscopic nature of the wax, which in the relative high vapour content and temperature of the surrounding air makes sectioning difficult. With time, the acetylcholinesterase activity gradually diminishes in the block. Several days after embedding it is still significant, and to obtain good results the incubation time should be increased by one-third to one-half. One month after embedding, the enzyme is difficult to demonstrate.

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Changes in the Amount of Nucleic Acids and Free Nucleotides during Early Embryonic Development of Sea Urchins

During the early embryonic period, the embryo of the sea urchin[1,2], and also those of the frog[3] and the chicken[4], live upon deoxypentose nucleic acid, stored within the cytoplasm of the embryo; this reserve is used for the nuclei as they increase in number. Only after a certain period of development does the embryo start synthesizing deoxypentose nucleic acid itself. The time of appearance of this new synthesis is naturally different in animals belonging to different orders; but even within the same group of animals, closely related species start this synthesis at varied developmental stages. We have found this to be true for some species of sea urchins, *Paracentrotus lividus* from Roscoff, France, *Psammechinus miliaris* from Roscoff and from Kristineberg, Sweden, and *Echinus esculentus* from Kristineberg. The embryos of *Paracentrotus* and *Psammechinus* were reared at + 18° C. and those of *Echinus* at + 12° C. When cultivated at 12° C., *Paracentrotus* and *Psammechinus* showed almost the same rate of development as *Echinus*.

For the estimation of the nucleic acids as well as for the free nucleotides a method was used[5] by which the homogenate is extracted with 10 per cent sodium chloride at + 85° C. Ribonucleic acid and deoxypentose nucleic acid were precipitated by ethanol. The nucleotides in the supernatant were precipitated by lanthanum acetate. Ribonucleic acid was separated from the deoxypentose nucleic acid by alkaline hydrolysis for 5 hr. The fractions were estimated spectrophotometrically in ultra-violet light. We have also compared this method to that of Ogur and Rosen[6] and found good agreement.

Fig. 1 represents typical series of measurements. On the average, five further series of determinations were carried out for each species, which all gave curves of identical shape. From the figure it is obvious that the three species investigated start the synthesis of deoxypentose nucleic acid at different stages: *Paracentrotus* at the 32-cell stage, *Psammechinus* at about a 100-cell stage and *Echinus* at about a 500-cell stage. The absolute amount of deoxypentose nucleic acid stored in the unfertilized egg may vary greatly within the same species. Thus we have found, for both *Paracentrotus* and *Psammechinus*, samples of eggs which contained only about one-tenth of the amount of stored deoxypentose nucleic acid indicated in Fig. 1, and in spite of this fact synthesis of the acid started always at the same stage and development led to normal plutei.

It seems as if during the earlier part of the breeding time the eggs contain more deoxypentose nucleic acid than in the later stages. Thus it is not the actual amount of stored deoxypentose nucleic acid in the single embryo which determines the moment at which the synthesis begins. However, on the average, the embryos of *Paracentrotus* contain the smallest amounts of stored deoxypentose nucleic acid and those of *Echinus* the highest. For *Paracentrotus* it has been shown earlier[7] that the synchronous cellular division which initiates embryonic development stops at exactly the same stage as the synthesis of new deoxypentose nucleic acid starts. This has now been demonstrated to be valid also for the two other species mentioned.

Testosterone propionate has been found to inhibit the formation of nuclear deoxypentose nucleic acid

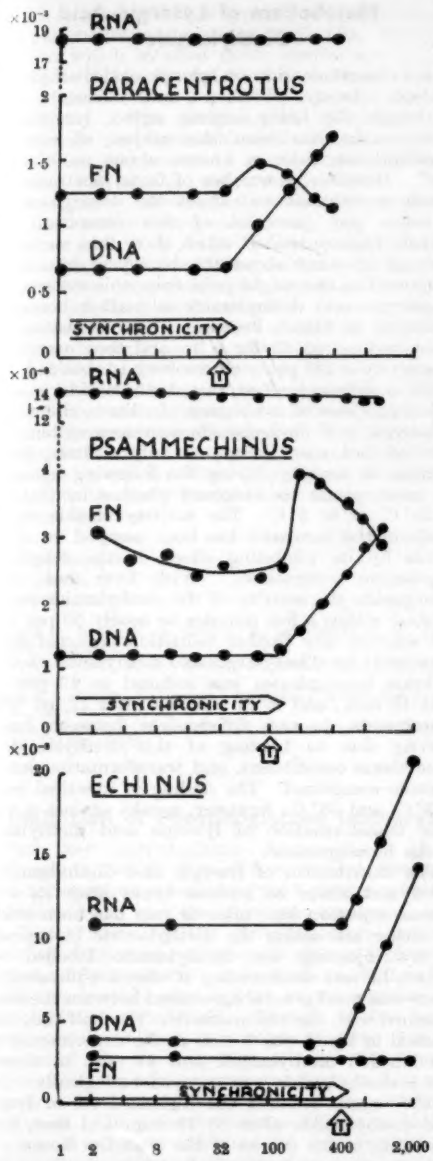

Fig. 1. Change in amount of deoxypentose ribonucleic acid (*DNA*), ribonucleic acid (*RNA*) and free nucleotides (*FN*) during the early embryonic development of three species of sea urchins. The period for the synchronous cellular division is indicated. The arrows marked *T* represent the moment when testosterone propionate added at the 2-cell stage inhibits cellular division and deoxypentose nucleic acid synthesis. Vertical axis: Amount of acid (γ) per embryo. Horizontal axis: embryonic stage expressed as the number of cells of the embryo

when its synthesis in *Psammechinus* begins[2] and correspondingly to block the cellular cleavage exactly when synthesis of the acid should start. Testosterone propionate has just the same action in the two other species. By the action of testosterone very broad chromosome bridges form at anaphase at the 16–32-cell stage in *Paracentrotus*. In *Psammechinus* these anaphase bridges form at the 128-cell stage and are long and slender. In *Echinus* the cells are just able to carry through the division at the 500-cell stage but die afterwards. Furthermore, it has been found that there is also a relation between the time when synthesis of deoxypentose nucleic acid starts and the time of hatching. The embryos of *Paracentrotus*, which start their synthesis of deoxypentose nucleic acid first, hatch as early as at about an 800-cell stage, *Psammechinus* at about a 1,000-cell stage and *Echinus* only after having divided to about 1,500 cells.

As regards the content of ribonucleic acid within the embryos, it is observed from the curves that during the embryonic development the ribonucleic acid remains constant for a long period. Only in *Echinus* is there a sudden new synthesis of ribonucleic acid, which occurs for some reason at the same time as the synthesis of deoxypentose nucleic acid. For the other two species the ribonucleic acid content has been followed beyond hatching without any sign of synthesis of new ribonucleic acid. It may be observed that for these two species the ratio of deoxypentose to ribonucleic acid is much higher than in *Echinus*. However, the course of the ribo- and deoxypentose nucleic acid curves for each species gives no support to any assumption of an interconversion of the two nucleic acids.

The amount of the free nucleotides is constant during the whole period investigated for *Echinus*, but shows a temporary increase around the time for deoxypentose nucleic acid synthesis in the other species. By paper chromatograms it has been found that new nucleotides form at this time, and we presume the visible change in the amount of the free nucleotides to reflect the turn-over rate of synthesis of deoxypentose nucleic acid. Thus, this synthesis may start with a synthesis of nucleotides, and not represent simply a process of polymerization.

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Specificity of Gold Thioglucose for Ventromedial Hypothalamic Lesions and Hyperphagia

In a recent publication[1] it was shown that gold thioglucose produces lesions in the ventromedial hypothalamic area of injected mice. It had previously been shown[2] that gold thiomalate, although similar to gold thioglucose with respect to toxicity, gold content and molecular weight, does not cause obesity; its injection does not lead to hypothalamic lesions[1]. To study further the specificity of gold thioglucose in causing ventromedial hypothalamic lesions and hyperphagia the action of other gold thio compounds was examined, in particular a compound where the gold thio moiety is linked to a radical very similar to glucose, namely, gold thiosorbitol (supplied through the kindness of Abbott and Co.), and compounds where the gold thio

moiety is linked to metabolites other than glucose: besides gold thiomalate, gold thiocaproic acid and gold thioglycerol were available (also supplied by Abbott and Co.). The effects of gold thioglycoanilide and gold sodium thiosulphate were also examined. The main dose of each compound used in these experiments was calculated to provide as much gold as is contained in the dose of gold thioglucose found most effective to yield obese mice. (In a series of 800 Swiss mice treated with gold thioglucose 1 mgm./gm. body-weight was found to induce obesity in 60 per cent of surviving mice and varying degrees of ventromedial hypothalamic damage in all animals examined.) For each compound in addition to the main dose a number of multiples and fractions of this standard dose were used.

Nearly a thousand mice were used. None of the gold thio compounds other than gold thioglucose proved effective in inducing obesity, although the general toxicity of several of the doses used was of the same order as that of the effective dose of gold thioglucose. Finally, to test the generality of the action of gold thioglucose, the effect of its administration on the central nervous system of rats was examined. In the rat, gold thioglucose administration does not lead to obesity. However, rats appear to be more susceptible to the toxicity of gold compounds in general; the lethal effect of a dose of gold thioglucose effective in causing hypothalamic lesions might mask this latter effect. Accordingly, rats were injected with 1 mgm./gm. of gold thioglucose; control animals were injected with an equal dose of gold thiomalate. The animals were killed after 24–72 hr. Hypothalami of animals injected with gold thioglucose showed lesions consisting of diffuse hæmorrhagic areas and pyknosis and degeneration of nerve cells throughout areas of œdema and hæmorrhage. In all cases the ventromedial area was the area involved, with the ventromedial nuclei, arcuate nuclei and in some cases the supraoptic nuclei partly or wholly obliterated. The picture obtained was very similar to that previously described in detail for mice[1]. Gold thiomalate administration did not induce any visible hypothalamic damage.

The results presented herewith are consistent with the view[1] that the presence of the glucose component in the molecule makes the ventromedial hypothalamic barrier much more permeable to this compound than to compounds not containing glucose. This area has been shown through behavioural methods[2] to be a 'satiety' area inhibiting periodically a constantly activated feeding mechanism. The present findings support the idea that the ventromedial area exerts its influence on food intake behaviour because of its property as a 'glucoreceptive' centre in the sense postulated in the glucostatic theory of the regulation of food intake[4].

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Metabolism of Lysergic Acid Diethylamide

In a communication on lysergic acid diethylamide, Axelrod, Brady, Witkop and Evarts[1] state: "Although the hallucinogenic agent, lysergic acid diethylamide, has been the subject of numerous investigations, little is known about its biological fate". However, a number of facts, not mentioned in this communication, about the destruction, distribution and excretion of this compound have recently been published which show that we are not quite as ignorant about the biological fate of this compound as one might infer from this statement.

Lysergic acid diethylamide is neither bound nor destroyed in blood, because, when incubated with blood (rat) at 38° C. for 6 hr. and then assayed for its activity a 100 per cent recovery is obtained. The result is different when this diethylamide is added to homogenates of rat organs. In these, the activity of lysergic acid diethylamide decreases within a few minutes, but there is no, or only a little, further decrease in activity during the following hours and the same results are obtained whether incubation is at 38° C. or at 3° C. The activity of this diethylamide in the incubates has been assayed on the rat uterus by its inhibiting effect on the 5-hydroxytryptamine contraction. With liver and muscle homogenate the activity of the diethylamide became reduced within a few minutes to nearly 50 per cent; but scarcely any further reduction occurred during the next 17 hr. The lysergic acid diethylamide activity of brain homogenates was reduced to 42 per cent after 10 min., and to 21 per cent after 17 hr. These experiments do not differentiate between loss of activity due to binding of this diethylamide to some tissue constituent, and transformation into an inactive compound. The finding of identical results at 3° C. and 38° C., however, speaks against a metabolic transformation of lysergic acid diethylamide in the homogenates[2].

The distribution of lysergic acid diethylamide in blood and tissue at various times after its intravenous injection into mice or rats has been studied by either estimating the diethylamide biologically[3], or by injecting the diethylamide labelled with carbon-14 and determining it chemico-physically[3,4]. There was good general agreement between the results obtained with the two methods. The half-time value reached in blood was 7 min. in the experiments with the labelled diethylamide and 37 min. in those in which diethylamide was assayed biologically. Most of the organs reached the highest level of lysergic acid diethylamide after 10–15 min. and then lost it gradually in the course of the next few hours. The highest concentration was found in the liver after 30 min., when it was about six times greater than in the blood. The order of decreasing concentration of lysergic acid diethylamide in other organs was: kidney, adrenals, lung, spleen, pancreas, large intestine, heart, skeletal muscle, skin, brain. The concentration in the brain was at all times lower than in the blood.

In the experiments of Boyd *et al.*[3] with labelled diethylamide, 7–8 per cent of the total activity was excreted within 12 hr., about half of this in the expired air, the rest in the urine and fæces, but 70 per cent was found in the intestinal contents. Stoll *et al.*[4] found 50 per cent of the injected dose in the intestinal contents within two hours after the injection.

There is no doubt that lysergic acid diethylamide or its metabolites are excreted in the bile. In experiments in which labelled diethylamide was injected into rats with bile fistulæ, Stoll *et al.* found that the bile contained within 2 hr. 70 per cent of the total radioactivity. The greater part of lysergic acid diethylamide undergoes chemical alteration because the excreted compounds or metabolites, in contrast to the diethylamide, were water-soluble. Paper chromatography revealed that the bile contained three radioactive compounds with the respective R_F values of 0, 0·13, 0·18. These compounds have not yet been identified chemically or biologically. The last two compounds give the Van Urk colour reaction and the blue fluorescence, characteristic for derivatives of lysergic acid, but neither of them is the 2-oxy-lysergic acid diethylamide, a compound obtained by Axelrod *et al.*, with *in vitro* "enzyme systems present in mammalian liver microsomes when supplemented with oxygen and a reduced triphosphopyridine nucleotide generating system". The problem of whether the third metabolite found in bile, which no longer gives the Van Urk colour reaction, is identical with 2-oxy-lysergic acid diethylamide has still to be examined.

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Inhibition of Phosphoglucose Isomerase

The key carbohydrate intermediate, glucose 6-phosphate, which may follow several alternative metabolic pathways including the 6-phosphogluconate oxidative cycle and the glycolytic sequence, enters the latter route by the phosphoglucose isomerase reaction. This reaction, in which glucose 6-phosphate is reversibly converted into fructose 6-phosphate, could conceivably play a part in the regulation of carbohydrate metabolism, although it has seldom been considered from this point of view, doubtless because of the extremely high activity of the enzyme in most tissues and because the reaction has so far appeared to be very little affected by extraneous influences. The present evidence suggesting that the enzyme is strongly inhibited by 6-phosphogluconic acid, an intermediate in the direct oxidative pathway, may therefore be of interest in connexion with studies on the mechanism responsible for the partitioning of carbohydrate between the direct oxidative pathway and the glycolytic route.

The enzyme reactions were carried out by a technique similar to that described by Bodansky[1]. Crude phosphoglucose isomerase extracts from mammalian blood, liver and muscle were employed. Various preparations of 6-phosphogluconic acid made by the bromine oxidation of glucose 6-phosphate[2] were used. With glucose 6-phosphate at a concentration of 0·002 *M* as the substrate, inhibitions of the order of 95 per cent were observed in the presence of equimolecular concentrations of 6-phosphogluconic acid, and inhibitions of about 75 per cent were obtained using 0·001 *M* 6-phosphogluconate. A similar inhibitory effect was demonstrated using fructose 6-phosphate as substrate.

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Separation of Neovitamin A_1 from All-Trans Vitamin A_1 by Chromatography on Alumina

In fish liver oils and synthetic preparations of vitamin A_1 it is possible to estimate the contents of the two isomers, neovitamin A_1 and all-trans vitamin A_1, by spectrophotometry following separation by chromatography on activated secondary calcium phosphate (dicalcium phosphate), length of column 300–600 mm.[1].

Even when the dicalcium phosphate has been subjected to the activation process previously described[1], the separation of the two vitamin A_1 isomers obtained is not equally satisfactory on all commercially available dicalcium phosphate preparations.

Earlier investigations have shown that a poor separation of the two vitamin A isomers is obtained by chromatography on columns consisting of the comparatively coarse-grained alumina which is usually marketed as suitable for chromatographic purposes. It has now been observed that good separation is obtained by chromatography on alumina prepared from fine-grained aluminium hydroxide.

The fractionation curve shown in Fig. 1 represents the results obtained by chromatographing 1·5 mgm. of a mixture of the alcohols of synthetic neovitamin A_1 and all-trans vitamin A_1. Chromatography was performed on a 75 cm. × 0·9 cm. column of aluminium oxide prepared as follows. Mixtures of diethyl ether and light petroleum with increasing contents of diethyl ether (2–25 per cent v/v) were used for the elution. Eluate was collected in 4-ml. fractions. On the basis of measurements of E_{325} for the individual fractions the ratio of the two vitamin A_1 isomers could be calculated. The result was: neovitamin : all-trans vitamin = 30 : 70.

The alumina used for the chromatography was prepared from aluminium hydroxide, analytical

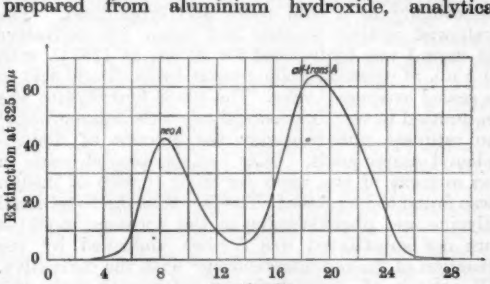

Fig. 1. Fractionation curve for synthetic neo- + all-trans-vitamin A_1 chromatographed on a 75 cm. × 0·9 cm. column of fine-grained alumina

grade ('Baker's analysed'), with a grain-size distribution characterized in that 100 per cent passes sieve *DIN* 80, while 97 per cent passes sieve *DIN* 100 and 70 per cent passes sieve *DIN* 150 *E*. A suspension of 10 gm. aluminium hydroxide in 40 ml. water has a *p*H of 9·6.

Aluminium hydroxide of this type is heated to 800° C. for seven hours[1] and cooled in an exhausted desiccator (a suspension of 10 gm. of this alumina in 40 ml. water has a *p*H of 10·2). Now 6·5 gm. distilled water is added to 100 gm. of alumina which has been transferred to a bottle with a close-fitting stopper. The bottle is shaken vigorously, and, when it has been allowed to stand for a couple of hours, the adsorbent is ready for use.

The rate of percolation through a 75 cm. × 0·9 cm. column of the prepared alumina was about 1·3 ml. per minute when applying a pressure of 0·4–0·5 atmosphere.

The losses involved in fractional chromatography were ascertained by comparison with the result of simple chromatography of 0·3 mgm. of the vitamin A_1 mixture used on a 10 cm. × 1·2 cm. column of dicalcium phosphate and simultaneous collection of the two vitamin A_1 isomers. The loss in this simple chromatography is 0·5–2 per cent[2]. The loss occurring in the fractional chromatography was about 10 per cent. In a similar fractional chromatography of 3 mgm. of vitamin A_1 on a 68 cm. × 0·9 cm. column of alumina the loss of vitamin A_1 was about 8 per cent.

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Preparation and Properties of Dinitrophenyl-NH(ε)-Insulin

The reaction of 2,4-dinitrobenzene sulphonate[1] with insulin has yielded a water-soluble and biologically active product. The only reactive group, which is shown to be substituted, is the ε-NH_2 of lysine in the hormone molecule.

30 mgm. of crystalline insulin (Eli Lilly) and 75 mgm. dinitrobenzene sulphonate were dissolved in 5 ml. 0·1 *M* sodium carbonate and was allowed to stand at 3° C. for 216 hr. The solution was then diluted to 25 ml. with distilled water, dialysed thoroughly in a cold room and lyophilized. The yellowish product weighed 30·5 mgm. The derivative (5 mgm.) was hydrolysed for 24 hr. at 110° C. with 0·5 ml. of constant-boiling point hydrochloric acid in a sealed evacuated tube. The whole hydrolysate was submitted to two-dimensional paper chromatography[2] to estimate quantitatively the amount of dinitrophenyl amino-acids. Only ε-dinitrophenyl-lysine in an amount of one mole per mole (6,000) of insulin was found to be present. The fact that the N-terminal glycine and phenylalanine in the hormone molecule are not substituted was further confirmed by the reaction of fluorodinitrobenzene[3] with the derivative. (Reactions of dinitrobenzene sulphonate with prolactin and ribonuclease also showed that terminal amino-groups are not dinitrophenylated.) Moreover, spectrophotometric analysis[4] of the derivative indicated that the tyrosine residue did not react with dinitrobenzene sulphonate under the experimental conditions. Since insulin contains only one lysine residue[5], the acid hydrolysate of the derivative gave no evidence for the presence of free lysine as analysed by two-dimensional paper chromatography in the solvent system previously described[6]. Thus, the derivative is dinitrophenyl-NH(ε)-insulin.

Preliminary studies showed that the solubility behaviour of dinitrophenyl-NH(ε)-insulin is similar to that of the native hormone. Unlike the dinitrophenylated insulin obtained by the fluorodinitrobenzene procedure[3], dinitrophenyl-NH(ε)-insulin is highly soluble in neutral solutions. In *p*H 7·2 trihydroxymethylaminomethane buffer of 0·10 ionic strength at 1° C., the derivative migrated as a single peak in a Spinco electrophoresis-diffusion apparatus with an electrophoretic mobility of $-7{\cdot}5 \times 10^{-5}$ cm.^{2} per volt per sec. which, as is to be expected, is lower than the value ($-6{\cdot}4 \times 10^{-5}$) obtained with native insulin. Additional physicochemical and biological characterizations of dinitrophenyl-NH(ε)-insulin will be presented at a later date.

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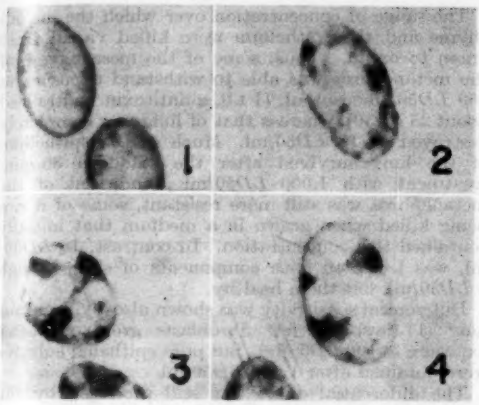
Possibility of Prenatal Diagnosis of Sex in Cattle and Sheep

We have previously shown[1] that a correct prenatal diagnosis of sex can be made in humans by an analysis of cells from the amniotic fluid. This method of diagnosis, which has also recently been used in other laboratories[2], is based on a determination of the percentage of amniotic fluid cells with a chromocentre, especially a chromocentre at the nuclear membrane, a criterion that has also invariably given correct results when applied to human cells from other sources[3]. Since this method is so accurate in humans, we have examined the possibility of its application to cattle and sheep.

Our study in cattle has been based on epithelial tissues taken from young and old males and females after birth; from a 6-week, an 8-week and a 16-week-old male fœtus; and from a 12-week-old female fœtus. It was found that the cells in these tissues, most of which have several chromocentres, do not have the clear sex differences found in humans (Figs. 1–4). In a previous study on cattle a sex difference has been reported for nerve cells[4]; but such cells would not be found in the amniotic fluid.

An examination of epithelial cells from young and old male and female sheep after birth has shown that most cells have several chromocentres, and that also in this species there is not the clear sex difference found in humans.

Since no clear sex difference has been found in the nuclei of epithelial cells in cattle and sheep, a



Photomicrographs of cells from sections of skin. Feulgen and fast green staining. 1, human male, nucleus without a chromocentre; 2, human female, nucleus with a chromocentre at the nuclear membrane; 3, bull, nucleus with several chromocentres; 4, cow, nucleus with several chromocentres

prenatal diagnosis of sex based on the determination of the percentage of amniotic fluid cells with a chromocentre at the nuclear membrane cannot be made in these domestic animals.

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γ-Amino-butyric Acid and Other Free Amino-acids in the Coconut

γ-AMINO-BUTYRIC acid has been described as present in the aqueous and alcoholic extracts of a number of plant and animal tissues[1–7]. In the course of studies on the nitrogenous constituents of coconut (*Cocos nucifera*) endosperm using paper chromatography, I have found this amino-acid to be present in amounts apparently larger than any other amino-acid except alanine in the watery liquid inside the mature fruit. Further investigations at three consecutive stages of development, namely, 4–5 months, 5–6 months and 6–7 months after setting of the fruit revealed that γ-amino-butyric acid is not present in the liquid endosperm at 4–5 months after setting of the fruit, but makes its appearance in the liquid when the solid endosperm has been deposited as a thin gelatinous layer on the nucellus in the fifth to sixth month after setting.

At this stage, γ-amino-butyric acid is barely detectable in two-dimensional chromatograms of concentrates of the fluid endosperm but is detectable in chromatograms of aqueous extracts of the solid endosperm. In the sixth to seventh month after setting when the solid endosperm has attained a thickness of about $\frac{1}{8}$ in., γ-amino-butyric acid can be clearly seen in both one- and two-dimensional chromatograms of concentrates of the liquid endosperm as well as in extracts of the solid endosperm. γ-Amino-butyric acid is not present among the products of hydrolysis of coconut globulin.

The γ-amino-butyric acid was identified in one-dimensional chromatograms by running an authentic sample of this amino-acid side by side with the solution being chromatographed; and in two-dimensional chromatograms both with and without addition of an authentic sample of γ-amino-butyric acid to the solution being chromatographed, as well as by the copper carbonate method of Crumpler and Dent[8].

The solutions used for chromatography were prepared by evaporating equal volumes of the endosperm liquid of fruits of different ages to small volume under reduced pressure and making up to equal volumes, the final concentration being 14–15 times. 2-ml. aliquots of these concentrates were passed through a 'Dowex 50' (15 cm. × 1 cm.) column, and after washing out the sugars with distilled water, the amino-acids were eluted with ammonia. The eluates were evaporated to dryness and the residues taken up in equal volumes of water. (Further elution of the columns with soda yielded only traces of ninhydrin-reacting substance.)

3–6-μl. aliquots of these solutions were used for one-dimensional chromatography and 6–12-μl. aliquots for two-dimensional chromatography. Phenol–water in the presence of 0·1 per cent ammonia and butanol/acetic acid/water (4 : 1 : 5) were used as solvents in the one-dimensional chromatograms which were run alongside a range of amino-acids, singly and in mixtures, on No. 1 Whatman filter paper; buffered (*p*H 9·3) *m*-cresol–phenol (1 : 1)[9] followed by butanol/acetic acid/water (4 : 1 : 5) using No. 3 *MM* paper gave the best results in two-dimensional chromatograms. After drying the papers in a current of air, they were sprayed with a 0·1 per cent solution of ninhydrin in butanol and heated for five minutes in an oven at 100° C. to develop the spots.

The following amino-acids were found at all stages of development studied: aspartic and glutamic acid, serine, alanine, valine, leucine and *iso*leucine. Threonine and glycine were present in much smaller amounts. Tyrosine, phenylalanine, tryptophan, α-amino-butyric acid and methionine could not be detected. In the case of the 6–7-month old fruit and the mature fruit, asparagine, glutamine, cystine, the basic amino-acids and β-alanine were found when larger aliquots of the liquid endosperm concentrates were used in two-dimensional chromatograms. Proline, in contrast to γ-amino-butyric acid, was present in largest concentration in the liquid endosperm of the immature fruit and decreased in amount with increasing maturity of the fruit until only a trace was present in the liquid endosperm of the fully mature fruit. Aspartic and glutamic acids increased somewhat and alanine and γ-amino-butyric acid increased markedly with increasing age of the fruit, while the others showed less marked variations. Concentrated aqueous extracts of the solid endosperm at 5–6 months and 6–7 months after setting and at maturity showed a distribution of amino-acids similar to that of the liquid endosperm at the 6–7 month stage. In addition, faint spots at positions corresponding to tryptophan, α-amino-butyric acid, tyrosine and phenylalanine were seen.

The appearance of γ-amino-butyric acid at the stage corresponding to deposition of the solid endosperm and its apparently increasing concentration in the liquid endosperm with increasing maturity of the nut suggest that this amino-acid arises as a result of some reaction connected with protein synthesis. A full account of this work will be published elsewhere.

I thank Dr. R. L. M. Synge and Prof. F. C. Steward for authentic samples of γ-amino-butyric acid; and Mr. B. P. M. Perera for technical assistance.

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Selective Destruction of Mesenchyme in Tissue Culture by the α-Toxin of *Clostridium welchii* Type *A*

The α-toxin of the gas-gangrene organism *Clostridium welchii* type *A* is one of the few lethal toxins of known enzymic action; it is a lecithinase *C*, which splits lecithin into phosphoryl choline and a diglyceride[1]. It affects the enzymic activity of isolated mitochondria and lyses red blood cells[2]. Unfractionated *welchii* toxin caused histological changes in fragments of tissues and organs, including the release of fat globules, lysis of nuclei, and general break-up, that agreed more or less with the clinical picture[4], and destroyed guinea pig spleen in culture[5].

In the present experiments, explants, about 1 mm. across, of the organs of chick embryos (6–13 day) were exposed to various dilutions of the toxin for 30 min. at 38° C., washed, and grown in a clot of plasma and embryo extract as 'hanging-drop' cultures.

Untreated explants from most organs produced an outgrowth of fibroblasts and wandering cells. If the organ contained epithelium, whether and how soon the latter grew out depended partly on its relations to the surface of the explant; if any epithelium appeared in the zone of growth, it was usually overgrown in subculture by fibroblasts. It was found that in some concentrations the toxin would eliminate the fibroblasts and wandering cells from the outgrowth of many organs, including lung, mesonephros, metanephros, thyroid, pancreas, and gut, and leave the epithelium flourishing. Stained sections of rather larger explants that had been grown by the watch-glass method showed that the internal mesenchyme had been killed. The results with lung were especially striking, for after the connective-tissue stroma had been destroyed, the unfettered bronchial system was able to unfold. In the absence of connective tissue, the epithelial cells became disarranged, and after two days the tubules had given place to sheets, strands, and small vesicles. Cell division was very common, and subculture yielded pure epithelium.

The range of concentration over which the mesenchyme and the epithelium were killed varied from organ to organ. Thus, some of the mesenchyme of the metanephros was able to withstand exposure to 100 *LD*50 (mouse)/ml. (1 I.U. α-antitoxin neutralized about 25 *LD*50), whereas that of lung was completely destroyed at 10 *LD*50/ml. Much of the epithelium of the lung survived after the standard 30-min. treatment with 1,000 *LD*50/ml.; and that of the metanephros was still more resistant, some of it not being killed when grown in a medium that initially contained this concentration. In contrast, 10 *LD*50/ml. was lethal to both components of skin, though 1 *LD*50/ml. left them healthy.

Differential sensitivity was shown also by fœtal rat lung (17-day); a few fibroblasts grew out after exposure to 100 *LD*50/ml., but pure epithelial cultures were obtained after 1,000 *LD*50/ml.

The differential effect was still produced by the lecithinase after the traces of other toxins present had been inactivated by specific antisera.

This lecithinase may prove a useful tool for obtaining pure cultures of epithelium. The methods so far available for this purpose have depended on the selective inhibition of mesenchymal growth, except in those organs in which the two components are readily separable; whereas the lecithinase actually kills the mesenchyme selectively. For preparative work, a comparatively crude toxin would be adequate.

It is not yet clear how these results are related to those of Davidson and Waymouth[7], who found that the lecithinase *A* of snake venom changed the appearance of the cells in explant chick heart from elongated to polyhedral.

I should like to thank Dr. H. B. Fell and Dr. W. Jacobson for their most helpful interest in this work, Dr. M. G. Macfarlane for providing purified toxin, Miss M. Barr of the Wellcome Laboratories for antisera and a further supply of toxin, and Mr. A. J. May and Mr. W. J. Randles for their assistance.

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Preservation of Corneal Endothelium by Freezing

The report[1] that spermatozoa from several species could be protected from the harmful effects of freezing by the addition of glycerol to the medium opened the way to the preservation for indefinite periods of a wide variety of mammalian tissues. An attempt to include the human cornea in this list[2] was only partially successful. It was suggested that the lack of complete success was due to the failure of the glycerol–saline technique to protect the corneal endothelium. It was therefore decided to investigate directly the effect of this treatment on the corneal endothelium of the rabbit.

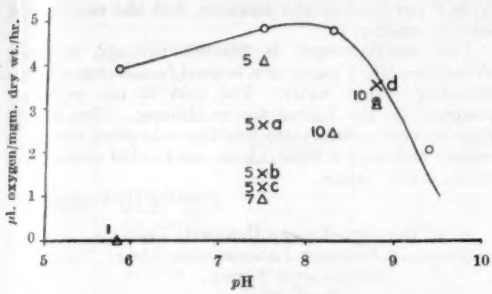

Fig. 1. The effect of *p*H, glycerol and freezing on the oxygen uptake of the corneal endothelium. ○, untreated corneæ; △, glycerol-treated corneæ; ×, glycerol-treated and frozen corneæ. The figure on the left of the symbol indicates the concentration of glycerol; the letter on the right the thawing procedure: *a*, thawed by immersion in water bath at 37° C. and maintained at that temperature for 60 min. before removal of endothelium; *b*, thawed at room temperature and allowed to stand 40 min. at room temperature before removal of endothelium; *c*, thawed by immersion in water bath at 37° C. (three minutes) followed by 20 min. at room temperature; *d*, thawed by immersion at 37° C. and maintained at that temperature for 20 min.

The criterion of viability employed was the oxygen uptake of the endothelium, and this was measured in a semi-microrespirometer designed specifically to respond to the small uptakes anticipated for a single endothelium. The whole, excised cornea was pre-treated with the experimental solution and the endothelium, a monocellular layer, was removed along with Descemet's membrane; the tissue weighed about 1·3 mgm. when dry.

Eastcott *et al.* treated their material with 15 per cent glycerol in saline for one hour before freezing. In a preliminary series of experiments it was shown that such a long period was unnecessary, possibly harmful, and that 30 min. was sufficient to allow the cornea to come to equilibrium with the solution bathing it.

The results of the main series of experiments are summarized in Fig. 1. In physiological saline (*p*H 5·85) it is seen that even 1 per cent glycerol is toxic but that the resistance to the toxicity of glycerol increases with *p*H. It is also seen that at *p*H 7·5 and a glycerol concentration of 5 per cent, up to about 50 per cent of the cells can be made to survive freezing at −79° C. At *p*H 8·8 the endothelium is completely resistant to the toxic action of 10 per cent glycerol and at this glycerol concentration and *p*H the endothelium is completely protected against the harmful effects of freezing and thawing.

With the exception of the physiological saline all solutions were buffered and contained sodium chloride, potassium chloride, magnesium sulphate, and glucose.

Corneal grafting experiments in rabbits are in progress employing tissue frozen at −79° C. after treatment with 10 per cent glycerol at *p*H 8·8. Full details of all this work will be published in due course.

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Effect of Testosterone and Androstene 3β-17α-Diol on the Activity of the Reticulo-endothelial System

It is now well recognized that the reticulo-endothelial system plays an important part in the defence of the body against infection. The cells act as scavengers in the later stages of acute infection, they function prominently in chronic infection and there is much circumstantial evidence to show that they play an important part in the production of antibodies. Nicol, Helmy and Abou-Zikry[1] found that the phagocytic activity of the reticulo-endothelial system could be increased by the administration of œstrogens. Unfortunately these substances have many unpleasant side-effects which restrict their use clinically. The influence of other steroids on the reticulo-endothelial system is therefore being investigated; the effects of cortisone[2] and deoxycorticosterone[2] have previously been reported.

The present communication deals with the effects of testosterone and androstene 3β·17α-diol. Forty-nine male guinea pigs were used. The reticulo-endothelial macrophages were studied by giving all the animals one daily injection of trypan blue subcutaneously for the last six days prior to being killed by chloroform. The dosage of the dye was calculated on the basis of 0·8 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. Seven of the animals were given dye only and were used as controls. The hormone treatment given to the remaining forty-two animals is shown in Table 1. Specimens were taken from the spleen, liver and lymph nodes and fixed in Heidenhain's 'Susa' fluid. Sections were cut at 10μ thick and stained with weak eosin, dilute carbol fuchsin or alum carmine. The activity of the reticulo-endothelial system in the organs studied was assessed by the number of dye-bearing cells and the intensity of the vital staining.

Table 1. Hormone Treatment given to Forty-two Animals

Number of animals	Hormone used	Daily dose intramuscularly	Duration of treatment
6	Testosterone propionate (Organon)	1 mgm.	1 week
6	,,	5 ,,	1 ,,
3	,,	5 ,,	2 weeks
9	,,	5 ,,	3 ,,
6	,,	5 ,,	4 ,,
6	Androstene 3β-17α-diol (Organon) dissolved in olive oil	1 ,,	1 week
6	,, ,,	1 ,,	3 weeks

The results were as follows:

Testosterone. In the group of animals which received 1 mgm. of testosterone daily for one week the intensity of the vital staining was slightly reduced in the macrophages of the spleen, but the appearances in the liver and lymph nodes remained similar to those of the controls. In those which received 5 mgm. daily for one and two weeks the intensity of the vital staining in the macrophages was slightly reduced after one week of treatment and markedly reduced after two weeks, the greatest reduction being seen in the macrophages of the spleen and liver. In the animals which received 5 mgm. daily for three or four weeks the phagocytic activity of the macrophages gradually returned to normal, and in those which received the hormone for four weeks the vital staining appearances were similar to those of the controls.

Androstene 3β-17α-diol. The animals which received 1 mgm. of androstene 3β-17α-diol once daily for one week showed vital staining appearances similar to those of the controls. In those which received 1 mgm. daily for three weeks there was marked reduction in the number of vitally stained macrophages and also in the intensity of the vital staining in the spleen, liver and lymph nodes.

The above results indicate that in the male guinea pig testosterone propionate depresses the phagocytic activity of the reticulo-endothelial system during the first two weeks of treatment; but if the injections are continued the system gradually recovers during the third and fourth weeks. The effect of testosterone is, therefore, similar to that of cortisone. Androstene 3β-17α-diol is also shown to have a depressant action on the activity of the reticulo-endothelial system.

For this research we gratefully acknowledge the gift of androstene 3β-17α-diol from Dr. Tindall, of Organon Laboratories, Ltd.

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Agar Clarification

The clarification of agar has always presented technical difficulties. The problem has become even more acute with the application of agar gels as a supporting medium for the interaction of antigen–antibody systems. A clear, transparent gel is essential for reading and photographing the lines, often fine and faint, formed by the antigen–antibody precipitates. That the classical microbiological methods of clarification, for example, filtration through sand and paper pulp, egg albumin coagulation, are insufficient is obvious from the elaborate, laborious methods devised in attempts to produce clear agar[1,2].

A very simple procedure for satisfactory agar clarification is here described. It is an adaptation of a step used by Viswanatha and Liener in the purification of a proteinase[3].

1 per cent w/v New Zealand agar is suspended in distilled water and dissolved by heating in a boiling water-bath. The solution is twice filtered rapidly through well-rinsed glass wool in a Buchner funnel to remove grossly insoluble particles. At this stage in our laboratory we add 1 per cent w/v sodium azide as a preservative, but this step is optional.

To the glass wool-filtered agar is added 1 or 2 per cent w/v of a mixture of equal parts of powdered bentonite and 'Hyflo Super-Cel' (Johns-Manville Co., Ltd.) and the whole shaken vigorously by hand to disperse the clarifying agents. The suspension is stored at 56° C. for several days, the clarifying agents being resuspended daily by gentle inversion of the bottles. When the cloudy flocculum is completely carried down from the supernatant by the bentonite–'Super-Cel' mixture the clarified agar is carefully decanted. Clarification is more quickly accomplished with 2 per cent of the mixture, but the recovery of agar is smaller.

The clarified agar is filtered through a fluted Whatman No. 5 paper in a heated funnel into a bottle standing in hot water. The first 25 ml. or so are returned to the funnel for re-filtering. The filtered agar in the molten state has the colourless clarity of water, and only a faint, clean, unclouded opalescence when set in plates.

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Validity of Miley's Electrometric Method for the Qualitative Analysis of Oxidation Layers formed on Copper

In a preliminary paper, published in 1951, L. de Brouckère, F. Bouillon and Y. Bouillon-Nyssen[1] showed that films formed on copper by anodic oxidation in molar solutions of sodium hydroxide contained, among other things, cupric hydroxide. This compound could be reduced electrochemically in 0·2 *M* solutions of ammonium chloride. The reduction potential was different from those of cuprous and cupric oxides, so that Miley's electrochemical method could, in principle, be applied to the qualitative analysis of mixed films. The various end-points were quite easy to localize.

The quantitative character of the electrochemical reduction of copper compounds in ammonium chloride solutions has been questioned by Campbell and Thomas[2], who suggested replacing it by potassium chloride, in which the copper oxides are completely insoluble. However, in this medium the potential-time curves are somewhat smoothed out, so that it is rather difficult to separate the various reactions occurring at the electrodes.

Ammonium chloride thus appeared to be the best electrolyte to use for qualitative analysis, potassium chloride being better suited for quantitative work.

Unfortunately, it has now been found that cupric hydroxide cannot be reduced in potassium chloride solutions, hydrogen being evolved from the very beginning of the electrolysis. A systematic study of these phenomena, which will be published shortly in the *Bulletin des Sociétés chimiques de Belgique*, has shown that copper hydroxide can only be reduced in such media as are able to dissolve it. Quantitative results can obviously only be obtained if the speed of reduction of the dissolved ions is greater than, or eventually equal to, the speed of dissolution.

We have been particularly interested in the reduction of copper compounds in solutions of sodium hydroxide as these have recently been used by several authors for analysing the films formed on copper by anodic oxidation[3]. Potential-time curves published in the literature generally have more than one horizontal part, and this has been interpreted as proving the complex nature of the films, which are supposed to consist of a mixture of cuprous and cupric oxides with some cupric hydroxide. We believe that this interpretation is not completely justified, especially

Table 1

Nature of the electrolyte used	General characteristics of potential-time curves		
	Films of 'pure' $Cu(OH)_2$	Films of 'pure' CuO	Films of dehydrated $Cu(OH)_2$
0·2 *M* KCl	No reduction	One long horizontal part (CuO) and one inflexion (Cu_2O)	One long horizontal part (CuO) and one inflexion (Cu_2O)
0·2 *M* NaOH	One long horizontal part and one inflexion	One long horizontal part and one inflexion	One long horizontal part and one inflexion
M NaOH	Three horizontal parts	One long horizontal part and one inflexion	One long horizontal part and one inflexion
4 *M* NaOH	Three horizontal parts	Three horizontal parts	Three horizontal parts

when strong sodium hydroxide solutions ($c \gg M$) are used.

The qualitative results presented here concern films made up of practically pure cupric oxide or hydroxide. Actually, as the primary product of anodic oxidation is always cuprous oxide, a small amount of this compound is probably present in every film; but it must be in very small quantity as it could not be detected in our X-ray patterns. Some of our results are summarized in Table 1.

Clearly, the number of kinks in the potential-time curve depends as much on the nature of the electrolyte used as on the composition of the layer analysed. In particular, complex curves can be obtained with films containing only one compound. Great care must therefore be taken in using Miley's method for qualitative purposes.

In a paper to be published later these results will be interpreted, and it will be shown that the total quantity of electricity used for reducing the film is proportional to the number of copper ions it contains. The method may therefore be used for quantitative measurements even when it fails for qualitative purposes.

This work was carried out under the direction of Prof. L. de Brouckère; we wish to thank her for help and criticism. We also thank the Union Minière du Haut Katanga for financial help.

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Polarographic Determination of Rate of Periodate Oxidation of Epimeric Open-Chain 1,2-Glycols

The use of glycol-splitting reagents for the study of structural features in alicyclic glycols and sugars is firmly established[1], but only isolated instances of the application of this method to the study of epimeric pairs of open-chain vicinal diols are known[2].

A new and very advantageous method for following the glycol fission by periodic acid has now been developed, based on the polarographic determination of the reagent. This procedure, which is widely applicable, has several advantages over current methods. It is accurate, rapid, measurement is semi-automatic and the kinetic data are obtained in a single run without sampling; this is particularly striking in fast runs, where a recording of the complete kinetic curve is obtained (Fig. 1). Only milligram amounts of material are required for complete kinetic measurements, which, moreover, may be carried out at greater dilution (10^{-3}–10^{-5} *M*) than has hitherto been possible, and over a considerable range of *p*H. The accumulation and disappearance of the reaction product (aldehydes) may be followed in some instances, and any possible over-oxidation[3] (disappearance of iodic acid) is readily detected.

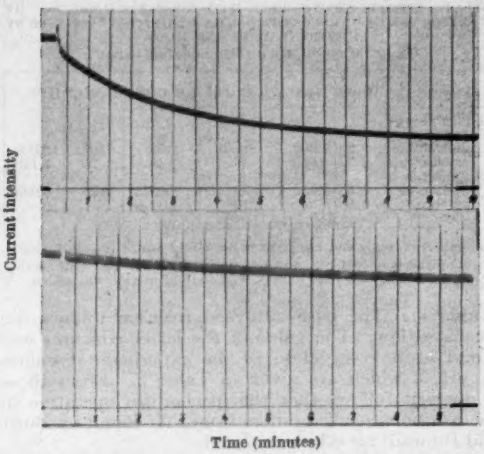

Fig. 1. Rate of oxidation of the threo- (upper curve) and erythro-1-phenyl-propane-1,2-diols in a 0·2 molar acetate-buffer of *p*H 4·7 with 1 molar sodium nitrate at 25° C., 6×10^{-4} molar glycol, 6×10^{-4} *M* periodic acid. The change of the current registered with time at 0 V. (S.C.E.). The distance between abscissæ corresponds to 0·5 min., first abscissa in $t = 0{\cdot}5$ min. Galvanometer sensivity $2{\cdot}2 \times 10^{-9}$ amp./cm.

The method has already found very useful applications in the elucidation of the structure of natural compounds available only in semi-micro amounts; for example, in determining the structure of laserpitine[4] and in a study of steric problems in steroid 16,17-diols (Fajkoš, J., and Krupička, J., unpublished results).

Our principal aim in developing the method, however, has been the study of the oxidation of a series of stereoisomeric pairs of open-chain disecondary glycols. It was hoped that the rate data might yield useful information regarding the mechanism of this reaction on one hand and the effect of the steric bulk of the substituents on the other.

The applicability of the method was first verified by observing the reaction of ethylene glycol with periodic acid. The results were in satisfactory agreement with those recently obtained by Buist and Bunton[5], who regard the decomposition of a relatively stable intermediate as the rate-determining step.

In contrast to this, the oxidation of disecondary glycols has been found to follow simple second-order kinetics. The reaction is generally acid-base catalysed; general acid-base catalysis has been reported previously for the periodate oxidation of pinacol[6]. Rate constants of the acid- and base-catalysed reactions and of the uncatalysed reaction were determined

Table 1. Specific Second-order Rate-constants (l mol.$^{-1}$s.$^{-1}$ at 25° C.) for the Reaction of Open-chain 1,2-Glycols catalysed by Different Acids and Bases

6×10^{-5} M glycol, 6×10^{-5} M potassium iodate

	Water	H_3O^+	CH_3COOH	CH_3COO^-	$H_2PO_4^-$	HPO_4^{2-}
1-Phenyl propane-1,2-diol: threo	9·2	1,360	Small	1,150	100	12,000
erythro	3·7	665	30	120	75	1,100
Butane-2,3-diol: threo	8·0	3,000	50	500	850	6,000
erythro	4·3	340	10	37·5	—	—

The values of k_{H_2O} and $k_{H_3O^+}$ have been determined in solutions containing nitric acid (pH 2–3) and 1 M sodium nitrate. To 0·2 M acetate and 0·07 M phosphate buffers, 1 M sodium nitrate was added

(Table 1). The base-catalysed reaction follows the Brønsted law. The value of the latter constant was found to be very close to the experimental values at pH 3, which are given in Table 2. From these findings it follows that the mechanism operative in the reactions studied differs from that found by Buist and Bunton[5] for ethylene glycol.

Consideration of the results presented in Tables 1 and 2 shows that the threo-epimers are in all instances oxidized faster than the erythro-isomers, the difference within the epimeric pair being more pronounced for the catalysed reaction than for the reaction in pure solvent. The difference in rates is sufficient to permit the analysis of mixtures of threo- and erythro-isomers and has, in fact, been successfully used for this purpose (Sicher, J., Šipoš, F., and Šorm, F., unpublished results. Šipoš, F., thesis, Institute of Chemistry, Prague). Furthermore, the reaction provides a simple and reliable method for determining the configuration of disecondary 1,2-glycols, provided both isomers are available. (The rate of reaction with glycol-splitting reagents has, of course, been frequently used for this purpose in the cyclohexane series. Recently, however, several instances have been reported in which the *trans*-isomer was oxidized faster than the *cis*[7].) On the other hand, the results show that the rate is not a simple function of the steric bulk of the substituents. Comparison of threo-isomers I, IX and IV, V points to an unexpected but marked accelerating effect due to the phenyl group; it should be noted that this effect does not occur with the corresponding erythro-isomer. The accelerating effect is apparently due to polar factors; it is, however, not enhanced by introducing the p-methoxy-group (VI). In the three purely aliphatic symmetrical glycols, k'_{threo} decreases with increasing size of $R = R'$, but again there is little variation in the corresponding value of k'_{erythro}. It should be noted that if the rate-determining step were the formation of a 'cyclic ester' or any geometrically equivalent species, it is the rate for the erythro-isomers which would be expected to vary with changes in R and R', rather than the rate for the threo-isomers.

Table 2. Second-order Rate-constants (l.mol.$^{-1}$s.$^{-1}$ at 25° C.) for the Reaction of Glycols with Periodic Acid

Values measured in 0·001 M nitric acid, 1 M sodium nitrate, 6×10^{-5} M glycol, 6×10^{-5} M potassium iodate (pH of the final solution adjusted to 3)

	R.CH(OH).CH(OH).R' R	R'	k'_{threo}	k'_{erythro}
I	Methyl	Methyl	9·9±0·1	4·3±0·2
II	Ethyl	Ethyl	8·8±0·1	4·4±0·2
III	Propyl	Propyl	5·5±0·1	4·9±0·1
IV	Cyclohexyl	Methyl	5·6±0·1	4·5±0·1
V	Phenyl	Methyl	10·1±0·4	4·6±0·1
VI	p-Methoxyphenyl	Methyl	9·8±0·4	5·2±0·1
VII	Phenyl	Ethyl	6·2±0·2	4·3±0·1
VIII	Phenyl	Isopropyl	11·5±0·2	3·7±0·2
IX	Phenyl	Phenyl	14·2±0·4	3·3±0·1

This investigation is being continued and will be published in detail elsewhere.

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Structural Characterization of Cæsium Antimonide: Temperature Factors in Cubic Crystals

We have completed an X-ray investigation of cæsium–antimony alloys which shows that the photo-electric surface material cæsium antimonide is a 'normal valency' intermetallic compound with a small range of homogeneity probably from Cs_3Sb to $Cs_{3-x}Sb_{1-x}$, where x, estimated from the observed variation of unit-cell dimensions, is of the order of 0·05. The atomic arrangement is pseudo body-centred cubic with a structure based upon the $B32$ sodium thallide type (NaTl). The cubic unit cell (a = 9·14–9·19 A.) contains sixteen atoms at special positions of space group $Fd3m$—O_h^7. Eight equivalent sites at (0,0,0; $0,\frac{1}{2},\frac{1}{2}$; $\frac{1}{2},0,\frac{1}{2}$; $\frac{1}{2},\frac{1}{2},0$) + 0,0,0; $\frac{1}{4},\frac{1}{4},\frac{1}{4}$ are occupied solely by cæsium atoms and eight other sites, at (0,0,0; $0,\frac{1}{2},\frac{1}{2}$; $\frac{1}{2},0,\frac{1}{2}$; $\frac{1}{2},\frac{1}{2},0$) + $\frac{1}{2},\frac{1}{2},\frac{1}{2}$; $\frac{3}{4},\frac{3}{4},\frac{3}{4}$, are occupied randomly by four cæsium and four antimony atoms. The structure may be described as consisting of two interpenetrating diamond-type lattices, one of cæsium atoms and the other of equal numbers of cæsium and antimony atoms. The semi-conducting properties of the material are explained by a filled Brillouin zone containing two electrons per atom. A full report of the investigation, together with a discussion of the cæsium antimonide structure and its correlation with other properties of the material, will be made elsewhere[1].

The observed X-ray diffraction effects from Cs_3Sb are accounted for only if the amplitudes of thermal vibrations are very much greater for cæsium atoms than for antimony atoms. In cæsium antimonide the root-mean-square displacements of the different atoms from their mean lattice positions (0·52 A. for cæsium and 0·25 A. for antimony at 291° K.) are approximately the same as the corresponding displacements in metallic cæsium and metallic antimony. This unexpectedly large difference between the Debye temperature factors of the different atoms (f_{Cs} = 55, f_{Sb} = 51 at $\theta = 0°$ for the electron distributions of the atoms at rest) causes the appearance of a complete

series of X-ray superlattice reflexions, with h, k and l all odd, which were at first erroneously thought to be due to specific shifts of some or all of the atoms from the special positions. Although the assignment of separate temperature factors to different atoms is well known[2], the need for this has been recently emphasized by Lonsdale and Grenville-Wells[3]. In discussing the different Debye factors observed for different reflexions of α-brass[4], Lonsdale and Grenville-Wells point out that the Debye factor for reflexions from a cubic crystal is independent of crystallographic direction only if all the atoms have similar thermal motions. They demonstrate that unless the exponential constant B is the same for all atoms, then the ratio F^R/F^T (R = rest, T = given temperature) will vary from one reflexion to another. They state that "the ratio may sometimes be less than 1; that is, the structure factor may be greater at high temperature than at a low one and may change sign".

The diffraction effects which we have observed from cæsium antimonide illustrate the validity of this statement in a striking way. For example, the values of the ratio F^R/F^{291} for a number of Cs_3Sb reflexions are listed in Table 1.

Table 1. VALUES OF THE RATIO F^R/F^T (T = 291° K.) FOR SOME Cs_3Sb X-RAY REFLEXIONS

θ	hkl	F^R/F^T
8·4	111	+2·75
13·8	220	+1·56
16·2	311	−1·02
19·7	400	+1·43
21·6	331	−0·49
42·4	800	+2·96
43·7	733	−0·21
72·5	880	+6·28
74·7	971	−0·24

At low Bragg angles the ratios for reflexions with h, k and l all odd are greater than 1 and may be positive or negative; at higher angles the ratios are negative and much less than 1. For reflexions with h, k and l all even the ratios are positive and greater than 1 but they show a wide range of values.

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Use of Radioisotopes in the Study of Wool Growth and Fibre Composition

Bern *et al.*[1], and Ryder[2], carried out hair-growth experiments involving the injection of mice with cystine labelled with sulphur-35 followed by the detection of radioactivity in the hair follicle using the autoradiographic technique of Pelc[3]. The preliminary results of similar experiments carried out with mice and lambs are presented here.

The shortest time after injection at which Bern took samples was 1 hr. In the present study moderate activity was detected in the vibrissal follicles of a mouse killed 6 min. after an intraperitoneal injection of about 40 microcuries of labelled cystine. Accumulation in the follicle of sufficient activity to produce an autoradiograph would be expected to take a little time. But the radioactive compound can be regarded as entering the follicle almost immediately after injection, because there was already slight activity in the follicles of a mouse killed only 2 min. afterwards.

Although there has always been activity in the bulb, it has never given a dense autoradiograph; even 6 min. after injection the densest autoradiograph was at a level higher up the follicle than the bulb. This stretched from the neck of the bulb into the fibrillary zone of the fibre, that is, the zone which gives the strongest reaction for sulphydryl groups and immediately precedes the pre-keratinization zone in which the sulphydryl reaction is less[3]. In the present study no activity was detected in the pre-keratinization (keratogenous) zone until two hours after injection when radioactive sulphur seemed to be just beginning to extend into that zone.

The immediate appearance of activity at a level higher than the bulb is in accordance with the findings of Bern[1], and seems to support his suggestion that compounds containing sulphur enter the follicle above the bulb. It also seems to support the suggestion of Ryder[2,4] that substances needed in keratinization could enter from the blood-vessel network surrounding the follicle. In addition, the greater grain density at levels higher than the bulb might suggest that in fact more sulphur enters from the surrounding net than the papilla.

In the lamb (skin sample taken ½ hr. after injection) the difference between the density of the autoradiograph of the bulb and of the regions immediately above it was less marked than in the mouse. The autoradiographic preparations were stained with Bennett's[5] sulphydryl reagent before the application of film, and the increase in grain density at levels of the follicle higher than the bulb is associated with increase in the reaction for sulphydryl groups. This suggests that the sulphur enters the follicle in a compound (probably cysteine) containing sulphydryl groups. But it may be that sulphur enters only through the papilla and that the autoradiograph is merely indicating the region with most sulphur. In fact, the sulphur arrives there so quickly that the entry route is uncertain. The possibility of growth up to that level is ruled out, and the short distance to the region with the strongest autoradiograph from the surrounding vessel net makes it tempting to suggest diffusion through the follicle wall, although the fluid content of the lower cells of the fibre would help diffusion up the fibre from the papilla. So far only sulphur fixed in the tissue has been detected; possibly frozen-dried preparations would show the route of sulphur into the follicle.

In the lamb perhaps the most striking finding was the uniformity in the density of the autoradiograph of the orthocortex and paracortex, that is, the dye-accessible and non-dye-accessible halves of the cortex of the fully formed fibre[6]. Mercer *et al.*[7] gave figures which suggested that the paracortex contained as much as two-thirds of the total cystine of the fibre. If this were so, one would expect the grain density of the autoradiograph of the paracortex to be twice that of the orthocortex. Autoradiographic preparations of fibres cut at about the level of the skin surface have been stained to show the orthocortex, and grain counts have been made of the density of the autoradiograph over each half of the fibre. The grains in three squares over each half of the fibre were counted at a magnification of × 1,080, using a ¼-mm. eyepiece graticule. A series of results is

Table 1. Autoradiographic Grain Density Counts

	Orthocortex (D.A.)	Paracortex (non-D.A.)
Fibres in skin sample taken 48 hr. after injection	28	41
	22	26
	23	18
Fibres in skin sample taken 5 days after injection	44	42
	47	34
	51	53
	56	51
	52	47
	59	65

shown in Table 1; no significant difference was found between the grain densities of the two halves.

The results obtained using this method therefore suggest that the orthocortex and paracortex each contain similar amounts of cystine.

I am indebted to Dr. A. Robson and Dr. M. C. Corfield for many helpful discussions on the procedure used, and for preparing the solutions used in the experiments. I wish to thank Mr. G. R. Standley for technical assistance.

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Intracrystalline Free Volumes in some Host Lattices

Various instances are known of continuous crystalline 'host' lattices within which 'guest' molecules may be trapped[1,2]. Organic lattices of this kind include the networks formed by hydrogen-bonded quinol molecules in the quinol clathrates; hydrogen-bonded urea and thio-urea networks in the urea and thio-urea adducts. Among inorganic lattices the best known are the crystalline zeolites, the most open of which, faujasite, easily occludes molecules as large as *iso*-octane; and two different kinds of hydrogen-bonded watter lattice, each with cavities able to encage diverse molecular species. It is of interest to compare aspects of the geometry of the free volumes of these host lattices, and to contract the free volumes of the organic and the inorganic lattices. It is also interesting to know the upper limit to the free volume in such continuous networks. Accordingly, the spatial properties of some cage and channel systems are summarized in Table 1. The term 'free', used above and in Table 1 in relation to channel and cage dimensions, means not occupied even by the periphery of any of the atoms forming the continuous network.

Quinol clathrates and water clathrates have free volumes in the form of separated cavities, the windows or apertures leading from one cage to another having very small free diameters. Urea and thio-urea adducts have free volumes in the form of continuous uniform capillaries, non-intersecting and all parallel to the hexagonal *c*-axis. The zeolites have free volumes in the form of cages joined by quite wide windows to each of several other cages, so that a continuous system of intersecting channels results[12], with free diameters varying periodically along their lengths. The zeolites of Table 1 differ from the other host lattices in being quite stable in absence of guest molecules, and in permitting migration of suitable small guest molecules from one cavity to another throughout the crystal.

Van der Waals[4] has pointed out that the atoms surrounding the cavity in the β-quinol-argon clathrate are located near the surface of a sphere of 7·9 A. diameter. On subtracting the equilibrium diameter 3·7 A. of an aromatic carbon atom one obtains a free diameter of 4·2 A. Subtracting the collision diameter of such an atom, 3·3 A., gives a diameter of 4·6 A. However, the β-quinol network is capable of some alteration according to the size of the included molecule. For the quinol-sulphur dioxide clathrate[1], the free diameter and volume may be found from the volume of sulphur dioxide, estimated as liquid, which is occluded per cm.³ of crystal (Table 1). In this network the free volume is comparatively small. The corresponding data for the urea-adducts have been calculated from the crystal structure given by Smith[5], and for thio-urea adducts from the corresponding work of Lenné[6]. By treating the channels in the host lattice as cylinders, and allowing 3·0 A. as the van der Waals diameter of nitrogen[13], one obtains the results given in Table 1. This time the free volumes are very substantial indeed.

The cage diameters of water clathrates of types 1 and 2 are taken from a paper by v. Stackelberg and Muller[7]. They are derived from the co-ordinates of the water molecules forming the wall of each cage, and the diameters of the water molecules. The latter were assumed equal to the distances between the centres of oxygen atoms of adjacent water molecules. Cage 1 is a pentagonal dodecahedron, cage 2 is a polyhedron with 14 pentagonal faces, and cage 3 a polyhedron with 16 pentagonal faces. The free volumes of Table 1 have been obtained taking the cubic unit cell edge of 12·0 A. for the type 1 and 17·3 A. for the type 2 water clathrate. In both these structures a large free volume exists, though

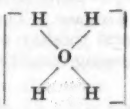
Table 1. Spatial Properties of Some Cage Systems

System	Free diameter of cage (A.)	Free diameter of apertures joining cages (A.)	Free volume enclosed by framework of host lattice (cm.³/cm.³)
Quinol-SO_2 clathrate (ref. 3)	5·2	Small	0·09
Quinol-*A* clathrate (ref. 4)	4·2	,,	0·05
Urea-*n*-paraffin adducts (ref. 5)	5·2	5·2	0·37
Thiourea-hydrocarbon adducts (ref. 6)	6·1₂	6·1₂	0·41
Type 1 water clathrate (ref. 7)	Cage 1 5·2 ,, 2 5·9	Small ,,	0·46
Type 2 water clathrate (ref. 7)	,, 1 4·8 ,, 2 6·9	,, ,,	0·46
Chabazite (refs. 1, 8)	7·3	3·2 [4·9]	0·46
Zeolite 4*A* (refs. 1, 9)	Cage 1~ 7	~3·2 —	0·46
Faujasite (refs. 1, 9, 10)	,, 2~11·8 ,, 1~ 7 ,, 2~12	~4·4 — ~3·2 — ~9 —	0·53
Gmelinite (ref. 11)	~7·3	~3·2 [4·9]	0·46
Erionite	—	— —	0·44
Levynite	—	— [3·8]	0·40
Harmotome	—	— —	0·35
Mordenite	—	— [4·0]	0·33
Analcite	—	— —	0·20

both lattices are metastable with respect to ice or liquid water unless a substantial fraction of the cavities is filled by guest molecules.

For the zeolites chabazite, '4A', and faujasite, structural details essential from the present point of view have been presented elsewhere[1]. Chabazite, for example, is built by stacking slightly distorted cubo-octahedral cages in 8-fold co-ordination[8], and gmelinite also seems to be based upon the same framework[11]. The free diameter of the cages and the free volume within the crystals have been derived from unit cell dimensions and from the volume of zeolitic water which may be displaced from them. Molecules somewhat larger than the free diameters of the windows connecting adjacent cages can diffuse through these windows by an activated diffusion process, and I[2] have therefore also given in connexion with the molecular sieve property the larger dimensions in the square brackets of Table 1, column 3, based upon diffusion experiments. These, however, are not free diameters. Table 1 shows free volumes for some zeolites as large or larger than those found for the water clathrates. For six of the host lattices of Table 1 the free volume is 0·46 cm.^{3} per cm.^{3} or above, and the maximum figure is 0·53 cm.^{3} per cm.^{3}. It is possible, but not proved, that this latter figure is about as large as the free volume of a stable host lattice could be. However, this is not necessarily true of networks filled with guest molecules, but unstable in their absence.

The arrangement of 'bonds' around the oxygen atoms of water in the water clathrates is a slightly distorted tetrahedron,



so that these structures are in this respect analogous to the alumino-silicates (zeolites). It is these networks, based upon the tetrahedron, which so often show large free volumes. It may be inferred that tetrahedron-based network phosphates and boro-silicates with large free volumes may be possible. Gallo-silicates, gallo-germanates and alumino-germanates showing this property have recently been synthesized in this laboratory[14]. The possibility of open-cage structures based on other ultimate building units, such as the octahedron, must, however, also be envisaged.

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The Hydrogen-Bond Strength of Ice

Pauling[1] estimated the strength of the hydrogen bond in water by taking the heat of sublimation of ice and allowing a reasonably guessed value for the dispersion contribution to the bond, and arrived at a value of 4·5 kcal./N bonds, where N was Avogadro's number. Later, Grunberg and Nissan[2] calculated the dispersion contribution from surface tension data by assuming that the dispersion energy equalled the work of cohesion as defined by Harkins[3]. By taking the internal latent heat of vaporization of water plus the heat of fusion as equal to the internal heat of sublimation of ice and subtracting the work of cohesion, a value of 3·71 kcal./N was obtained. They also made a calculation from the dipole moment (taking certain evidence from viscosity data into account) and found a value of 3·23 kcal./N. Recently, I[4] formulated a relationship between the elastic constants of cellulose sheets and the strength of the hydrogen bond. The same relationship should apply to ice and therefore it should be possible to calculate the bond energy from the modulus of elasticity.

Consider a cube of ice in which the crystallites are randomly oriented and let a uniaxial tensile stress f act on two faces producing a small strain $\delta\sigma$. The energy per unit volume stored in the cube δU is the product $f\delta\sigma$, or taking infinitesimal quantities

$$f = \frac{dU}{d\sigma} \qquad (1)$$

If the orientation of the crystallites, or hydrogen bond direction, is assumed random, then, to a first approximation, we can take $\frac{1}{3}$ of the total bonds available to be in the direction of strain. Thus the volume which a strained hydrogen bond occupies will be v_m, where

$$v_m = 3 \times 18/N\rho \sim 100 \text{ A.}^3 \qquad (2)$$

where N is Avogadro's number and ρ the density of ice. While it is permissible to think of dU on a macroscopic scale as distributed uniformly in the volume of ice, on the molecular scale we imagine it localized in the O—H and O..H bonds. If r_1 and r_2 are the bond-lengths of the O—H and O..H links, and if the bond-strengths are k_1 and k_2 respectively, then a macroscopic strain of $d\sigma$ will distribute itself among the two links according to

$$d\sigma = d\sigma_2\,(r_2/v_m^{1/3})\,[1 + (k_2/k_1)] \qquad (3)$$

Therefore, $f = (dU/d\sigma)$

$$= (dU/d\sigma_2)/\{(r_2/v_m^{1/3})\,[1 + (k_2/k_1)]\} \qquad (4)$$

Taking the Morse function for $U(\sigma_2)$ as was done for cellulose sheets, we obtain

$$f = 2(a_2)^2\left[\frac{v_m^{1/3}}{r_2(1 + (k_2/k_1))}\right]^2 U_0\sigma - \text{terms in higher powers of } \sigma \qquad (5)$$

$$\text{So } E = \lim_{\sigma\to 0}(f/\sigma) = 2(a_2)^2\left[\frac{v_m^{1/3}}{r_2[1 + (k_2/k_1)]}\right]^2 U_0 \qquad (6)$$

where a_2 is Morse constant, of order 2; U_0 is energy of dissociation of the hydrogen bond per unit volume of material $= J\Delta H/1{,}000\, v_m\, N$; and J is mechanical equivalent of heat.

It follows, then, that ΔH in kcal./N bonds is given by

$$\Delta H = Er_2^2\,[1 + (k_2/k_1)]^2\, v_m^{1/3}\, N/2{,}000\, a_2^2 J \qquad (7)$$

Values for E reported in the literature for ice[5] are grouped around $1{\cdot}05 \times 10^{11}$ within $\pm\, 0{\cdot}05 \times 10^{11}$. Substituting the values for the other parameters

(that is, $r_2 = (2{\cdot}76 - 1{\cdot}07) \times 10^{-8}$; $k_2 : k_1 \sim 1 : 8$; $v_m = 10^{-22}$) gives $\Delta H = 3{\cdot}2$ kcal./N bonds against 3·2 from the dipole moment and 3·7 from thermodynamical data. It appears that a figure of $3{\cdot}4 \pm 0{\cdot}2$ kcal./N bonds is the most probable value of the hydrogen bond energy for ice and water.

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A Solar Magnetograph

The first test observations for the detection and measurement of both small magnetic fields and small Doppler effects on the Sun's surface have been carried out during recent months at the Cambridge Observatories with a photoelectric magnetometer newly built under a grant from the Department of Scientific and Industrial Research. This instrument is a modified version of one constructed by H. W. Babcock some time ago at the Mount Wilson and Palomar Observatories[1]. It is used in conjunction with the Cambridge solar spectrograph which has a large diffraction grating of excellent quality, ruled by H. W. Babcock[2] and working in the 5th order, where it reaches a measured resolving power of 600,000. The Zeeman effect in a suitable Fraunhofer line is analysed with the aid of an electro-optical retardation plate of ammonium di-hydrogen phosphate and a fixed 'Polaroid'. The retardation of the plate oscillates in sign at 400 c./s. due to the applied potential of 3·5 kV. r.m.s. A selected portion of each wing of the Fraunhofer line is imaged on the cathode of a corresponding photomultiplier (*E.M.I.* type 6094). The outputs from the two photomultipliers are fed into a difference amplifier, and the resulting signal after amplification by a selective frequency amplifier is applied to a phase-sensitive rectifier. Time constants up to 10 sec. are provided. The difference amplifier rejects elliptical polarization from the cœlostat mirrors, and, provided the examining slits are correctly placed, small Doppler shifts of the line are relatively unimportant.

Directly the instrument was brought into operation it revealed a wealth of magnetic structure on the Sun's surface, as was expected from observations already made in Pasadena[3]. One of the most striking phenomena is the presence of comparatively large fields not located on any surface feature visible in ordinary integrated light. These frequently occur at some distance from an apparently single sunspot, near where one would expect to find the following spot of an ordinary pair, and with the appropriate polarity with respect to the leading spot. The existence of such fields appeared probable in rare cases from work carried out long ago by G. E. Hale[4], but they are rather difficult to detect by purely photographic methods, as were, for example, tried by one of us[5] using a kind of blink method. With the present instrument they are detected with ease.

If the slit-length of the spectrograph is reduced to about 4 sec. of arc on the disk, very small areas with rather strong fields, up to about 100 gauss, can, under the present conditions of high solar activity, be found in large numbers along the main sunspot belts, even when in white light nothing but undisturbed photosphere can be seen on the surface. Some of these fields may occur over very tiny spots or over the well-known pores which appear among the photospheric granules. Small optically visible spots have developed in some of these patches one or two days after their discovery, suggesting, as has already been anticipated from theory, that a magnetic field is probably the precursor of a sunspot. The long-standing problem as to where the lines of force leaving the Sun's surface in a spotted area eventually return to the surface may be brought nearer solution by observations of this kind.

The fact that very small areas, apparently only a few square seconds of arc in extent, sometimes reveal relatively strong magnetic fields suggests that the magnetic structure of the Sun's surface may be appreciably finer than can be resolved by the instrument in its present form. It may well be that the dimensions of this fine structure will in future be found comparable in character with the Doppler fine structure recently discovered in Fraunhofer lines both here and elsewhere[6,7] by the use of large diffraction gratings of exceptionally high quality.

The sensitivity of the present instrument is sufficient to detect fields of the order of one gauss, but only with a relatively long slit, which results in highly localized and rather strong fields being smeared out into apparently larger and rather weak fields.

The instrument can be adapted to measure very small shifts of Fraunhofer lines down to quantities of the order of 1μ, equivalent to Doppler shifts of a small fraction of 1 km./sec. The limit so far has been set by the general rigidity of the spectrograph building and by the seeing conditions.

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Photoelectric Polarimeter using the Faraday Effect

The sugar industry is becoming increasingly interested in the possibility of replacing polarimeters of the visual type with photoelectric instruments. Of the various designs which have been suggested, a promising one is that in which the plane of polarization of the light emerging from the polarizer is made to oscillate through a suitable angle. When the analyser is perpendicular to the mean direction of the plane of polarization, the emergent light intensity, though it may be modulated at twice the frequency of oscillation, has a zero alternating component at the fundamental frequency. This condition is detected by means of a photocell and amplifier, the system thus combining the advantages of a.c. amplification and of the half-shadow principle used in visual polarimetry.

The various mechanical methods which have been suggested for producing the desired oscillation of the plane of polarization are not very suitable for a commercial instrument, and it is therefore rather surprising that the potentialities, in this connexion, of the magneto-optic or Faraday effect have been overlooked. The amplitude of oscillation which can be so obtained is rather small, but this is not necessarily a disadvantage, as the following argument shows.

If θ is the total angle through which the plane of polarization swings, then the sensitivity, that is, the rate of change of photocell output with angle of analyser, varies as $\sin\theta$ and is therefore greatest for $\theta = 90°$. The precision, however, when it is limited solely by shot noise in the photocurrent, is greatest for $\theta = 0$, since the root-mean-square shot noise varies as the square root of the mean photocell illumination, that is, as $\sin\theta/2$. Moreover, the accuracy, as distinct from the precision, is likely to be limited mainly by disturbances of the kind which appear as a modulation of the light intensity. In terms of angle, therefore, the resulting errors may be expected to vary as (mean light intensity) ÷ (sensitivity), that is, as $\tan\theta/2$. It follows that both precision and accuracy will improve progressively with decreasing θ until θ reaches a limiting value where the sensitivity is so small that extraneous disturbances (for example, dark-current or amplifier noise) begin to take effect.

Experiments indicate that, if a photomultiplier is used as the detector, this limiting value of θ is well within the capabilities of a Faraday cell of practical design. The following details of the construction and performance of an experimental instrument may serve to illustrate this conclusion.

The Faraday cell employed a lead–zinc borate glass (Chance *DEDF* No. 030,181, Verdet constant about 0·14 min./gilbert) in the form of a cylindrical rod 10 cm. long and 1 cm. diameter. The coil surrounding this was wound with 18 *SWG* enamelled copper wire on a Keramot former to these dimensions: int. diam. 1·4 cm.; ext. diam. 3·6 cm.; length 11·5 cm. The coil was supplied with 1 amp. of alternating current at 50 c./s. (sinusoidal waveform), which sufficed to swing the plane of polarization through an angle θ of 6° with a power dissipation of only 1 watt. The detection system comprised an 11-stage photomultiplier, a.c. amplifier, phase-sensitive rectifier and output meter.

The 'light-gathering power' of the optics, as determined by the size and separation of the stops, was if anything rather less than that of a typical visual polarimeter. The instrument was illuminated with 5461 A. light from a mercury lamp and monochromator; the effective light flux may be judged from the fact that, with analyser and polarizer *parallel*, the primary photocurrent was about 2×10^{-9} amp.

In these circumstances, the root-mean-square fluctuation in meter reading, for a bandwidth, as set by the overall response time, of 0·1 c./s., was equivalent to about 1 second of arc in the angular setting of the analyser, a value quite close to the shot-noise limit. The stability over a period of several minutes was of the same order. These results indicate a performance much superior to that of a visual polarimeter, and have encouraged us to proceed with the design of a similar instrument suitable for industrial use.

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this communication is published by permission of the Director of the Laboratory. Acknowledgments are due to Mr. S. P. Middleton for the design of the Faraday cell and assistance in the experimental work.

E. J. Gillham

National Physical Laboratory,
Teddington,
Middlesex.
Sept. 11.

Population Growth

Dr. C. B. Goodhart's article, "World Population Growth and its Regulation by Natural Means"[1], performs a useful service in emphasizing that 'family size' may be a very poor indicator of the extent to which the descendants of a family will increase or decrease in number over a period of generations. This latter property might be termed 'net reproductive capacity'. As he points out, family size and net reproductive capacity might be positively correlated in some circumstances and negatively correlated in others.

However, if as Dr. Goodhart suggests the 'families of low fertility' may be replacing the more fertile lines during the present period of rapid population increase (because of a greater net reproductive capacity when disease is controlled, etc.), there is still a difficulty in accepting that as a result " . . . the mean fertility should fall and the population should taper off to a new position of equilibrium at a much higher level of numbers . . . ". This surely could only happen if there were some sharp curtailment of the superior net reproductive capacities of the 'less fertile' after they had succeeded in displacing the 'more fertile lines'. In other words, after the tortoise has beaten the hare, what reason have we to believe that he will stop running?

More important, however, is a second point, which Dr. Goodhart has touched upon only briefly. We know almost nothing about the differentials in net reproductive capacity which may exist within a population. In spite of this, there is continued speculation concerning the possible effects of such differentials on the size and quality of future human populations. The time would seem to be ripe for a shift in emphasis from speculation to a serious consideration of the feasibility of observing the differentials themselves.

Limited surveys are probably inadequate for such a purpose, but there is an alternative approach. Essentially complete information of the kind required exists, although unfortunately not in a readily available form, in the routine registrations of marriages, births and deaths. These are sufficiently specific in their information content to identify parents and offspring unambiguously. Thus individual lines of descent could conceivably be followed over an indefinite number of generations. Of course, to reconstruct even a single family tree from such back records by a process of searching would be excessively laborious.

At first sight it is difficult to imagine any simple procedure for making use of this kind of record to derive the net reproductive capacities for lines of descent differing with respect to family size, or some other important attribute. However, it is altogether possible that current procedures for obtaining vital statistics from these registrations could be modified

to permit the future extraction of appropriate family data for whole populations, and spanning an indefinite number of generations.

There is reason for believing that such modified handling procedures might perhaps prove quite simple in operation. Until recently, no serious thought had been directed to this end; but preliminary discussions in Canada, initiated for a rather different reason, suggest that some form of population accounting which takes cognizance of the family relationships from generation to generation may in fact be feasible. Without going into details, the essential feature lies in bringing together by means of a coding system (such as might be used with a punch-card medium) those records relating to the births, marriages and deaths of the offspring from a single pair of parents. There are a number of ways in which this can be accomplished. The product is in essence a family tree of the population, complete with the dates of all events, family sizes, causes of death, and, eventually, degree of consanguinity of the parents.

Most of the speculations regarding future populations imply that the problem is of practical importance. If so, is it not time that we started recording and handling our vital statistics to permit appropriate observations to be made on the differentials of reproduction, so that we shall not always be forced to draw conclusions about future populations from such meagre data? The possible negative correlation between family size and number of descendants which Dr. Goodhart postulates represents only one of the possible relevant kinds of observation.

Howard B. Newcombe

Biology Branch,
Atomic Energy of Canada, Ltd.,
Chalk River, Ontario.
Oct. 17.

[1] Goodhart, C. B., *Nature*, **178**, 561 (1956).

There is perhaps one way in which the tortoise might be expected to continue to slow down after he has beaten the hare.

The suggestion was that families (in the sense of 'lines of descent') of low average fertility might come to predominate in the population as a result of selection for success in life when indiscriminate mortality was low. This low average fertility is seen as being due to their having a high proportion of individuals who are subfecund, whether as a result of physiological sterility or because they are 'psychologically infecund' and disinclined to marry or have children. Such infecundity, whether physiological or psychological, is congenital and likely to be at least partly conditioned by inherited genetical factors, so that its already surprisingly high incidence in some communities must be the result of natural selection. It was suggested that this selection for relative infecundity (correlated with other inherited characteristics of high survival value) was likely to be extended in the future. If that does indeed happen, and the incidence of subfecundity is seriously increased, then the rate of population growth should continue to slow down for so long as the selection pressure is maintained; and that is not directly dependent upon the total numbers of the population, nor upon its average fertility.

C. B. Goodhart

Museum of Zoology,
University of Cambridge.

Splitting of Genera

The recent passion for the progressive splitting up of genera has spread through most branches of zoology and latterly to botany as well. In fact, the present phase in taxonomy is to lump species and split genera, thus making genera on the whole as small as possible. In some groups (for example, Heteroptera, Cypraeidae, birds of paradise) this practice has reached absurd limits. The steady march of this practice goes almost unnoticed until large general or popular books are compiled where all recent work is uncritically assimilated regardless of quality. Two such Australian works on shells[1,2] and a recent book on birds[3] are illustrations. They admirably serve their purpose of presenting to the public excellent well-illustrated identification handbooks; but the nomenclature used is highly unstable, which is particularly undesirable in a book of wide public appeal.

The solution for this problem lies with the two International Commissions for Nomenclature. It is not, of course, denied that a very large number of genera remain to be described; but the burden of proving their complete distinctness rests with the describer. At present, names are very often proposed on flimsy grounds and the work of proving their validity or otherwise is handed down to future workers. For example, Steadman and Cotton[4] have summarized the 'accepted' classification of the Cypraeidae, and the genera and even subfamilies are separated on characters which are no higher than specific. New genera are established using merely the specific characters of the unique species included without any additional evidence. The result is that two species such as *Cypraea tigris* L. and *C. pantherina* Sol. are placed in different genera, whereas they are only just distinct species which actually hybridize.

Such absurdities should have no standing in nomenclature. I would propose that taxonomists consider a clause to be added to the international rules laying down that no generic name proposed after a certain date (possibly placed in the past) has any standing unless full reasons are given for its separation, not merely that it must be accompanied by a description. The interpretation of the term 'full reasons' is, of course, of paramount importance and varies from group to group. For example, no mollusc genus should be proposed without a comparison of its anatomy with allied genera. Each group has its accepted characters used for differentiation purposes and these should be used. If in a group the main classification depends on one character, then the description of a new genus should include full details of that character. I believe some such clause is needed to prevent certain branches of taxonomy developing into a farce. The mere extra labour involved in describing more than the macromorphology will prevent many of the offenders from too lightly proposing names.

B. Verdcourt

East African Herbarium,
P.O. Box 5166,
Nairobi, Kenya.
Sept. 21.

[1] Allan, J., "Australian Shells" (Melbourne, 1950).
[2] Allan, J., "Cowry Shells of World Seas" (Melbourne, 1955).
[3] Roberts, A., "The Birds of South Africa" (London and Johannesburg, 1940).
[4] Steadman, W. R., and Cotton, B. C., "A Key to the Classification of the Cowries", *Rec. S. Aust. Mus.*, **8**, 503 (1946).

FORTHCOMING EVENTS

Thursday, December 27

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Dr. H. Baines: "Photography". (First of a course of six lectures adapted to a juvenile auditory. Further lectures on December 29, January 1, 3, 5 and 8.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade A, FOR GENERAL CHEMISTRY, at Birkenhead Technical College—The Director of Education, Birkenhead Education Committee, 63 Hamilton Square, Birkenhead (December 28).

HEAD (honours graduate in chemistry, physics or metallurgy, with teaching, industrial and/or research experience, Corporate Member of a Professional Institution, and preferably experience of administration in a Senior Technical College) OF THE DEPARTMENT OF PURE AND APPLIED SCIENCE (Grade II), at Enfield Technical College, Queensway, Enfield, Middlesex—The Secretary to the Education Committee, Middlesex County Council, 10 Great George Street, Westminster, London, S.W.1, quoting Ref. F/CW/2 (December 29).

PHYSICS GRADUATE IN THE DEPARTMENT OF RADIOTHERAPY, for duties which include physical investigations concerned with the clinical use of rotation therapy, multicurie cobalt units, low voltage X-rays and radioactive isotopes, and also some teaching of radiographer students—The Assistant Administrator, The Churchill Hospital, Headington, Oxford (December 29).

ASSISTANT LECTURER or LECTURER (preferably with special qualifications and interests in mineralogy and petrology) IN GEOLOGY—The Registrar, University College of North Staffordshire, Keele, Staffs (December 31).

RESEARCH FELLOW (male graduate in some branch of physical science, with experience of observing, and preferably also of photographic work) to assist the Superintendent at the Norman Lockyer Observatory, near Sidmouth—The Secretary, The University, Exeter (December 31).

LECTURER or ASSISTANT LECTURER IN MATHEMATICAL STATISTICS—The Registrar, The University, Manchester 13 (January 1).

CHEMIST (with a degree of a British university and/or Associate Member of the Royal Institute of Chemists) with the Basildon Development Corporation, Sewage Treatment Works, to make chemical analyses of sewage effluent, trade wastes, etc.—The General Manager, Basildon Development Corporation, Gifford House, Basildon, Essex (January 4).

HOSPITAL BIOCHEMIST, Senior grade (with a university degree in science or equivalent qualification) in the routine Biochemical Section of the Department of Clinical Biochemistry—The Administrator, Radcliffe Infirmary, Oxford (January 4).

RESEARCH FELLOW or SENIOR RESEARCH FELLOW IN POULTRY SCIENCE in the Faculty of Rural Science—The Registrar, University of New England, Armidale, New South Wales, Australia (January 7).

HEAD (with an engineering degree, Corporate Member of a Professional Engineering Institution, experience in industry and preferably as head of a department or senior lecturer in a technical college) OF THE DEPARTMENT OF ENGINEERING, Singapore Polytechnic—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (January 15).

LECTURER (with a good honours degree, diploma in education, and suitable teaching experience) IN GEOGRAPHY, in the Department of Teacher Training, Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (January 15).

PHARMACOLOGIST (with a university honours degree with physiology and biochemistry as major subjects, and research experience in pharmacology) at the Laboratories of the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Parkville, Victoria, Australia, to undertake and expand investigations on the pharmacological and toxicological properties of substances extracted from Australian plants, with special reference to alkaloids—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment No. 201/105 (January 19).

DRUMMOND FELLOWS FOR RESEARCH IN NUTRITION—The Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1 (January 31).

LECTURER IN PSYCHOLOGY at the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, January 31).

ASSISTANTS IN CHEMISTRY—The Secretary of University Court, The University, Glasgow (February 1).

POSTGRADUATE RESEARCH SCHOLARS FOR RESEARCH IN CHEMISTRY, HOUSEHOLD SCIENCE, NUTRITION or PHYSICS—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8 (March 1).

ASSISTANT or ASSOCIATE PROFESSOR (with graduate training in physics, and research and practical experience in the field) OF GEOPHYSICS—Head, Department of Physics, University of British Columbia, Vancouver 8, B.C, Canada.

ISOTOPE ASSISTANT (with a first- or second-class honours degree in physics or physiology)—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5.

LABORATORY TECHNICIAN (with G.C.E. science and mathematics, preferably at advanced level, or laboratory qualifications) IN THE PHYSIOLOGY DEPARTMENT to assist with research—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

LABORATORY TECHNOLOGIST (preferably A.I.M.L.T., and at least two years experience in a medical or veterinary biochemistry laboratory) in the Nigerian Federal Government Department of Veterinary Research, to assist the Biochemist in investigation of normal and abnormal conditions in livestock—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3/43811/NF.

LECTURER (with a good degree and preferably industrial experience) IN METALLURGY—The Secretary, Royal College of Science and Technology, Glasgow.

PARAPSYCHOLOGISTS (preferably married couple under 30, with degrees in psychology or allied subjects), to assist with the work of the Institute—The Director, Institute for the Study of Mental Images, Church Crookham, Hants.

PHYSICISTS, PRINCIPAL SCIENTIFIC OFFICERS to fill responsible positions in a group developing prototype military reactors, and SENIOR SCIENTIFIC OFFICERS/SCIENTIFIC OFFICERS to assist them—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. A.1255/34.

RESEARCH OFFICER (with at least a Bachelor's degree in physics or engineering physics, plus several years experience in the theory of wave propagation, seismology and acoustics) IN THE DIVISION OF BUILDING RESEARCH, National Research Council of Canada, Ottawa, for duties which will include basic research in ground vibrations, their propagation and their effect on building structures; dealing with construction problems relating to ground vibrations; studying effects on building structures of earthquakes, blasting, pile-driving, etc., and developing suitable instruments for the above studies—The Employment Officer, National Research Council, Sussex Drive, Ottawa 2, Canada, quoting Br.169.

SCIENTIFIC OFFICERS (CHEMISTS) IN THE METROPOLITAN POLICE LABORATORY—The Secretary, Room 165(8), New Scotland Yard, London, S.W.1.

SENIOR TECHNICIAN IN THE ZOOLOGY DEPARTMENT—The Secretary, Royal Holloway College, Englefield Green, Surrey.

STATISTICIAN (with a degree in statistics or mathematics, and preferably experience in industry), to act as chief assistant to the Head of the Statistics Department, which deals with a wide range of problems in fundamental and industrial research, calling for the use of varied statistical and mathematical techniques—The Secretary, The Hosiery and Allied Trades Research Association, 4 First Avenue, Sherwood Rise, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of Her Majesty's Civil Service Commissioners for the period 1st April, 1955, to 31st March, 1956. Pp. 39. (London: H.M. Stationery Office, 1956.) 2*s*. 3*d*. net. [1710

British Institution of Radio Engineers. 30th Annual Report of the Council of the Institution for the year ending 30th March, 1956. Pp. 14. (London: British Institution of Radio Engineers, 1956.) [1710

The Registrar General's Statistical Review of England and Wales for the year 1953. Text Volume. Pp. xv+250. (London: H.M. Stationery Office, 1956.) 9*s*. net. [1710

Proceedings of the Instrumentation Appreciation Conference, Hotel Majestic, Harrogate, 19th to 22nd April, 1956. Pp. vi+183. (London: Association of British Chemical Manufacturers, 1956.) 12*s*. 6*d*. [1710

British Museum (Natural History). Scientific Research at the Natural History Museum. Pp. vi+46. (London: British Museum (Natural History), 1956.) 2*s*. 6*d*. [1710

Planning. Vol. 22, No. 403 (8 October 1956): Ordinary Families and the Social Services—Piloting an Enquiry. Pp. 189–204. (London: Political and Economic Planning, 1956.) 2*s*. 6*d*. [1710

Research Defence Society. Conquest Pamphlet No. 1: Anti-Poliomyelitis Vaccination. Pp. 4. (London: Research Defence Society, 1956.) 3*d*. [1710

Water Research Association. First Annual Report, 1955–56 (July 1st–June 30). Pp. 24. (Redhill: Water Research Association, 1956.) [1710

Pipes and Pipelines. Vol. 1, No. 1 (October, 1956). Pp. 36. Published monthly. Subscription rates: 40*s*. (7 dollars) for one year (12 issues); 100*s*. (17.50 dollars) for three years (36 issues). (London: Scientific Surveys, Ltd., 1956.) [1710

General Register Office. The Registrar General's quarterly return for England and Wales. Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates, quarter ended 30th June 1956. Pp. 24. (London: H.M. Stationery Office, 1956.) 1*s*. 6*d*. net. [1710

University of London. University College Calendar, 1956–57. Pp. lxiv+508. (London: University College, 1956.) [1710

Building Research Station Digest No. 92: Pulverized Fuel Ash in Building Materials. Pp. 4. (London: H.M. Stationery Office, 1956.) 3*d*. net. [1710

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Bulletin of the British Museum (Natural History). Entomology. Vol. 4, No. 8: A Revision of the *Brullia* (Mallophaga) Species Infesting the Corvidæ, Part 1. By M. Atiqur Rahman Ansari. Pp. 369–406. (London: British Museum (Natural History), 1956.) 10*s*. [1710

British Cast Iron Research Association. Thirty-fifth Annual Report for the year ending June 30th, 1956. Pp. 24. (Alvechurch, Birmingham: British Cast Iron Research Association, 1956.) [1710

Medical Research Council Special Report Series, No. 291: The Hazards to Men in Ships Lost at Sea, 1940–44. By R. A. McCance, C. C. Ungley, J. W. L. Crosfil and E. M. Widdowson. Pp. vi+44. (London: H.M. Stationery Office, 1956.) 5*s*. net. [1710

Spaceflight. Vol. 1, No. 1 (October, 1956). Pp. iv+44. Published quarterly. (London: British Interplanetary Society, 1956.) 3*s*. [1710

Bulletin of the British Museum (Natural History). Botany. Vol. 2, No. 3: Novitates Himalaicae—1. Pp. 65–81+plates 1–8. (London: British Museum (Natural History), 1956.) 10s. [1710

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for 1955. Northumberland and Cumberland Division. By H. Hyde. Pp. ii+30+6 plates. (London: H.M. Stationery Office, 1956.) 2s. 6d. net. [1710

A Stake in the Future. By Fred Moorhouse. Pp. 16. (London: Fellowship of Reconciliation, 1956.) 1s. [1710

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 963, Vol. 249 (18 October 1956): An Investigation of Wind Structure in the Trades: Anegada 1953. By H. Charnock, J. R. D. Francis and P. A. Sheppard. Pp. 179–234. (London: Royal Society, 1956.) 17s. 6d. [1710

Flora of Tropical East Africa. Edited by Dr. W. B. Turrill and E. Milne-Redhead. Rhizophoraceae. By John Lewis. Pp. 20. (London: Crown Agents for Oversea Governments and Administrations, 1956.) 2s. 6d. [1710

Science and the Humanities. By Sir Gavin de Beer. (Rickman Godlee Lecture delivered at University College, London, 25 October 1956.) Pp. 21. (London: H. K. Lewis and Co., Ltd., 1956. Published for University College, London.) 2s. 6d. net. [1710

Scottish Marine Biological Association. Annual Report, 1955–56. Pp. 36. (Millport, Isle of Cumbrae: Scottish Marine Biological Association, 1956.) [1710

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Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich für das Jahr 1955. Von E. Rübel und W. Lüdi. Pp. 136. (Zürich: Geobotanische Forschungsinstitut Rübel in Zürich, 1956.) [1710

Geological Map of Nigeria (1954). (Scale 1:2,000,000.) (Kaduna Junction: Director of Geological Survey.) [1710

Boletim do Museu Nacional, Rio de Janeiro. Nova Series. Zoologia. No. 131: Fauna do Distrito Federal. 12: Sôbre o Gênero *Morellia* R.-D. (*Diptera-Muscidae*). Por Dalcy de O. Albuquerque. Pp. 45+12 plates. No. 132: Fauna do Distrito Federal. 34: Novo Gênero para *Halisidota Leucanina* Feld., 1874 (*Lepidoptera-Heterocera*). Por Alfredo Rei do Rego-Barros. Pp. 18 (4 plates). No. 133: Fauna do Distrito Federal. 30: Três Espécies Novas de *Coenosiinae* (*Diptera, Muscidae*). Por Dalcy de O. Albuquerque. Pp. 11. No. 134: Contribuicao ao Estudo da Familia *Arctiidae*. 4: Rediagnose de *Hemihyalea* Hampson, 1901 e de Gêneros (*Lepidoptera-Heterocera*). Por Alfredo Rei do Rego-Barros. Pp. 66 (12 plates.) No. 135: Ictiofauna de Pirassununga. 2: Sôbre *Characidiinae* H. Travassos, 1952 (*Cypriniformes—Characoidei*). Por Haroldo Travassos. Pp. 14. No. 136: Fauna do Distrito Federal. 31: Contribuicao ao Conhecimento do *Euryomma* Stein, 1899, com descricao de uma Espécie Nova (*Diptera-Muscidae*). Por Dalcy de O. Albuquerque. Pp. 8. (Rio de Janeiro: Universidade do Brasil, Museu Nacional, 1956.) [1710

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Bulletin of the American Museum of Natural History. Vol. III, Article 2: Results of the Archbold Expeditions. No. 75: Summary of the Fourth Archbold Expedition to New Guinea (1953). By L. J. Brass. Pp. 77–152+plates 10–21. (New York: American Museum of Natural History, 1956.) 1.50 dollars. [1710

United States Naval Observatory. Circular No. 67: Positions, Areas, and Counts of Sunspots. February, 1956. By Winifred Sawtell Cameron. Pp. 8. Circular No. 68: Positions, Areas, and Counts of Sunspots, March, 1956. By Winifred Sawtell Cameron. Pp. 8. (Washington, D.C.: United States Naval Observatory, 1956.) [1710

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Commonwealth Scientific and Industrial Research Organization. Soil Publication No. 7: Pedology and Chemistry of the Basaltic Soils of the Lismore District, N.S.W. By K. D. Nicholls and B. M. Tucker. Pp. 153+3 maps. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1956.) [1710

New Zealand: Department of Scientific and Industrial Research—Geophysics Division. Seismological Observatory Bulletin No. E-133: July, August, September, 1953, Wellington, other New Zealand stations, and Fiji. Pp. 19. (Wellington: Government Printer, 1956.) [1710

United States Department of Agriculture. Technical Bulletin No. 1147. Investigations of the Tomato Fruitworm: Its Seasonal History and Methods of Control. By Joseph Wilcox, A. F. Howland, and Roy E. Campbell. Pp. ii+47. (Washington, D.C.: Government Printing Office, 1956.) 25 cents. [1710

Responses of Vegetation to Fire: a Study of the Herbaceous Vegetation following Chaparral Fires. By James R. Sweeney. (University of California publications in Botany, Vol. 28, No. 4.) Pp. 143–250+plates 12–27. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1956.) 2 dollars. [1710

Annals of the New York Academy of Sciences. Vol. 64, Article 2: Some Protozoan Diseases of Man and Animals: Anaplasmosis, Babesiosis, and Toxoplasmosis. By C. Cole and 19 other authors. Pp. 250. 3.50 dollars. Vol. 64, Article 3: Calcium and Phosphorus Metabolism in Man and Animals with special reference to Pregnancy and Lactation. By F. McLean and 29 other authors. Pp. 192. 4 dollars. Vol. 65, Article 1: Effects of Natural Selection on Human Genotypes. By L. Dunn and 2 other authors. Pp. 32. 1.25 dollars. Vol. 65, Article 2: On the Cell Model for Solutions. By S. A. Rice. Pp. 24. 1.25 dollars. Vol. 66, Article 1: Epidemic and Endemic Diarrheal Diseases of the Infant. By E. Neter and 54 other authors. Pp. 300. 3.50 dollars. (New York: New York Academy of Sciences, 1956.) [1710

Union of South Africa. Department of Commerce and Industries: Division of Fisheries. Investigational Report No. 22: The South African Pilchard (*Sardinops ocellata*), Sexual Maturity and Reproduction 1950–54. By Dr. D. H. Davies. (Reprint from *Commerce and Industry*, April 1956.) Pp. 155. (Pretoria: Government Printer, 1956.) [1710

United States Department of Agriculture. Index-Catalogue of Medical and Veterinary Zoology. Supplement 5: Authors A to Q. By Mildred A. Doss, Judith M. Humphrey and Dorothy B. Segal. Pp. ii+971–1374. (Washington, D.C.: Government Printing Office, 1956.) 1.50 dollars. [1710

The Agricultural Value of Phosphate Fertilisers which Economise in the Use of Sulphuric Acid: Report on a Study by Dr. George W. Cooke, Rothamsted Experimental Station. Pp. 90. (Project No. 162.) (Paris: European Productivity Agency of the Organization for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 300 francs; 6s.; 1 dollar [1710

Indian National Scientific Documentation Centre. Inadoc Report, 1955–56. Pp. ii+25. (New Delhi: Indian National Scientific Documentation Centre, 1956.) [1710

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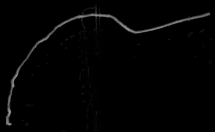
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